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**STEAM PER HOUR**
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# 4,800-H.P. 1,500-VOLT ELECTRIC LOCOMOTIVE OF THE FRENCH NATIONAL RAILWAYS.

THE 4,800-h.p. 1,500-volt locomotives which are now being used on the electrified section of the French National Railways between Paris and Lyons,* are the result of researches carried out by the Société Générale de Constructions Electriques and Mécaniques Alsthom, 38, Avenue Kléber, Paris, 16e, with the object of producing an express engine having high adhesion without guiding axles. A design based on this principle would have the advantage, it was considered, of cutting down the dead weight, with a corresponding saving in cost, and would also enable the load hauled to be increased, or the energy consumed to be reduced. Further investigations were conducted with the object of reducing the weight on each axle without increasing their number. Two prototype locomotives embodying these features were built and, with the collaboration of officials in the appropriate departments of the French National Railways, were used to haul both passenger and freight trains between Paris and Bordeaux. In the course of these trials an average monthly mileage of some 14,000 was satisfactorily run, a maximum of over 20,000 miles per month being covered during the summer season. While these trials were in progress tests were also made on the mechanical portion with a view to reducing the lateral forces to a minimum and to verify the stability, even where the track was not of first-class quality. The success of these tests is shown by the fact that one of the locomotives ran 328,000 miles before a general overhaul became necessary. At the conclusion of these tests the prototype locomotives were transferred to the Paris-Lyons section of the French system where, as mentioned in the article referred to above, they are now being used to haul express passenger trains. It has been decided to employ them instead of two other types and 60 more are at present being constructed by the Alsthom organisation. In addition, ten similar locomotives are being supplied to the Dutch National Railways.

* See ENGINEERING, vol. 174, page 654 (1952).

The general appearance of these Co-Co locomotives is shown in the illustrations reproduced in Fig. 1, on this page, and in Fig. 2, overleaf, while their construction will be clear from Figs. 6 and 7, Plate XX. An idea of their size may be indicated by saying that the length over the buffers is 62·4 ft. and that the length and width of the body are 58·5 ft. and 9·8 ft., respectively. The total wheelbase is 46·6 ft. and the wheel diameter 4·12 ft., while the maximum height with the pantographs lowered is 14 ft. The total weight is 106 metric tons, all of which is available for adhesion. About 64 metric tons of this weight are accounted for by the mechanical and the rest by the electrical equipment, while the individual axle-load is 17·6 metric tons. These figures may be compared with those of the 2-Do-2 locomotives which are also being used on this line and weigh 144 metric tons. Owing to the difference in design, however, only 82 metric tons of the latter weight is available for adhesion.

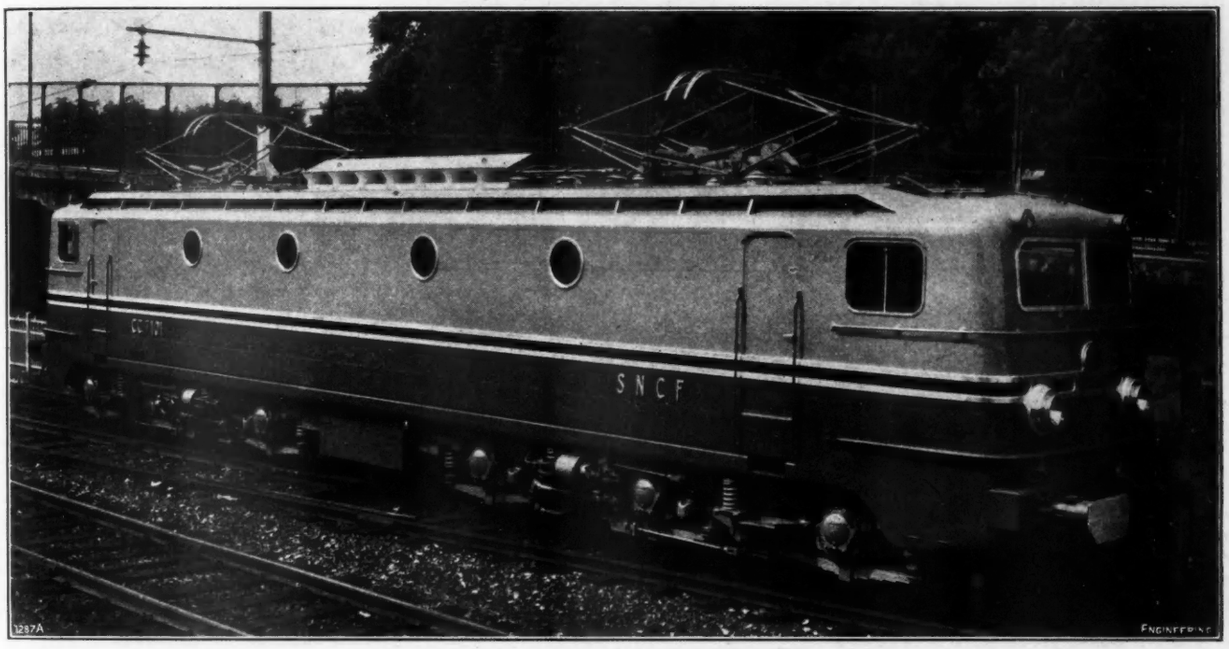



FIG. 1. GENERAL VIEW OF 4,800-H.P. 1,500-VOLT LOCOMOTIVE.

## MECHANICAL CONSTRUCTION.

The body and bogie frames of these 4,800-h.p. locomotives are constructed of electrically welded plates, the principal parts being of box section, thus giving the maximum ratio of rigidity to weight. The use of welding has enabled an extremely homogeneous and continuous structure to be obtained, thus facilitating the transmission of the stresses and allowing each part to take its proper share of the load. The body is also of box-section construction with flexible sheet-steel side walls. The sheets forming these side walls are secured under tension to the sills and the fastenings of the roof members are such that a high degree of vertical rigidity as well as resistance to buffing shocks has been obtained. As will be seen from Fig. 1, portholes form the only openings in the body and these are surrounded with solid circular frames, so that the adjacent panels can take up the diagonal forces. In accordance with the usual practice of the French National Railways, the principal parts of the body, including the floor, sides, cab bulkheads and the cabs themselves were pre-fabricated separately and then assembled by welding. The central part of the locomotive between the cab bulkheads is open for a length of about 46 ft., thus providing space for the auxiliary machines and other equipment.

The constructional methods adopted have enabled pressed parts to be used for the bogie frame, thus eliminating the abrupt changes in section which frequently give rise to trouble. The principal parts, including the longitudinals and cross members, consist of two symmetrical semi-circular pressings which were pre-fabricated and connected by welding to give the desired tubular design. The arrangement of the bogies will be clear from Figs. 10 to 14, Plate XXI, which also show the various features dealt with in more detail below.

## BOGIE DESIGN.

An interesting feature of the design of these locomotives is that there are no normal bogie pivots. Instead, the bolsters are connected to the frame through two swinging pivots, the ends of which are carried by rubber cones, as shown in Fig. 9, Plate XX. These pivots are arranged so that they can swing laterally, and when they move in opposite directions, the bogie rotates relatively to the body. On the other hand, when they move in the same direction, lateral displacement occurs between them. Both movements are restricted, so that the tractive forces are transmitted in the same way as with a normal bogie pivot. Their motion is, however, sufficient to allow curves with a radius of four chains to be negotiated. In both cases restoration to the vertical is effected by the springs on the links. A number of advantages are claimed by its designers for this system. From the constructional point of view it is simpler and neater than the usual three-axle bogie with a single bolster, as the latter necessitates the staggering of the lateral supports, owing to one of the traction motors being centrally situated. It also ensures stability more simply than does the usual system. Moreover, the transverse movement which may occur between the frame and bogies can be regulated by adjusting the initial stress on the springs on the links, while the position of the normal bolster is practically unchangeable once its construction has been completed. From the point of view of the lateral forces set up when unevenness in the track is encountered, this type of bogie has the peculiarity that only the pivot nearest the irregularity is affected, so that the shock between the bogie and the track is greatly reduced. On the other hand, when a continuous lateral force is set up, such as by centri-

# 4,800-H.P. 1,500-VOLT LOCOMOTIVE FOR FRENCH NATIONAL RAILWAYS.

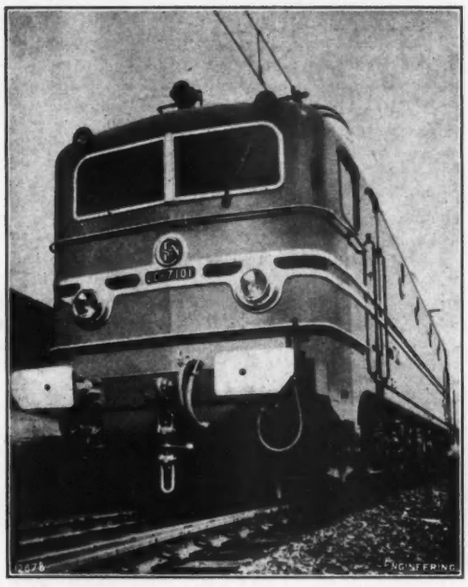


FIG. 2. FRONT VIEW OF LOCOMOTIVE.

FIG. 3. SERVICE CORRIDOR.

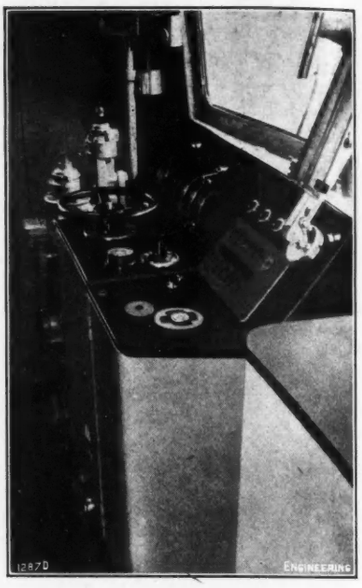


FIG. 4. DRIVER'S CAB.

fugal force on a curve, the two pivots operate simultaneously with the result that the lateral stresses on the leading wheel on the outside of the curve are distributed in the best possible way.

As regards adhesion, the employment of two bolsters on each bogie ensures that both the bogies themselves and the frames are maintained parallel until a point is reached where crushing of the rubber cones is imminent. The primary suspensions can, therefore, be completely balanced. Moreover, as the traction motors are entirely suspended and exert no direct vertical stress on the axles, the load on each bogie is equally distributed between the three axles. The unloading of the axle due to the difference between the tractive effort at the rail and the resistance at the coupling is therefore reduced to a minimum. Thus, as regards loading, the two-pivot system has the same advantages as the rigid design, while from the point of view of stability it possesses the advantages of the articulated arrangement in which the bolsters are widely separated.

### DRIVING ARRANGEMENTS.

The motors which, as has been said, are wholly suspended, are fixed to the bogie frame and drive the individual axles through double-reduction gearing, which is mounted on a hollow shaft. The flexible coupling between this hollow shaft and the axle is of the Alsthom "dancing" ring type with articulated connecting rods carried on Silentblocs, as shown in Fig. 5. The axleboxes, which are illustrated in Fig. 8, Plate XX, are provided with two lugs, which are arranged on an oblique diameter. These lugs carry articulated rods which rest on Silentblocs, an arrangement which allows vertical movement of the axle to take place without fore-and-aft deviation. These Silentblocs are provided with square ends which are mounted in recesses formed in the lugs and in the bogie frames. They are maintained in position by bolts and can be dismantled easily and rapidly. The system has the advantages that there is no wear or play between the boxes and the frames, and that lubrication is unnecessary. The Silentblocs also allow a certain flexibility in the transverse direction, thus facilitating the passage of curves and the negotiation of track unevenness by considerably reducing the forces on the rail.

Additional elasticity has been provided by designing the axleboxes so that the axles and their bearings can slide axially through a distance of 10 mm. in both directions. To ensure this, flexible V-springs have been inserted between the steel casings of the box itself and the bearing and were subjected to an initial stress of 5 metric tons. When an axle encounters track unevenness which gives rise to a reaction of not more than 5 metric tons, it retracts and the lateral stress on the track remains at approximately this value so long as the 10-mm. play is not exceeded. Generally speaking, the unevenness has passed before the latter condition has been reached, so that the arrangement effectively limits the transverse forces on the rail to 5 or 6 tons, or much less than would cause damage to the track.

FIG. 5. AXLE DRIVING ARRANGEMENT.

### BRAKING EQUIPMENT.

Two braking cylinders are provided on each bogie and the rigging is designed to produce a braking coefficient of 80 per cent. with an air pressure of 3·5 hectograms per square centimetre. It is, however, proposed in future to increase this pressure to between 5 and 5·5 hectograms per square centimetre, thus giving a braking coefficient of 120 to 130 per cent. in cases where the French National Railways intend to employ a braking effort which varies with the speed. The rigging is fitted with two double-action regulators which automatically maintain the blocks, when in the "off" position, at a distance from the wheels depending on the wear.

In designing these locomotives great care was taken to reduce wear and thus the need for lubrication. All friction surfaces which are required to withstand high pressures or to undergo movements of relatively high amplitude are either of manganese steel or are provided with liners of the same material, thus eliminating the necessity for lubrication, without any risk of seizure. The number of frictional surfaces has also been reduced by the use of articulated links resting on Silentblocs, while appropriately shaped rubber pads have been inserted between the surfaces of pivots the movements of which have only small amplitudes and where pressures set up are relatively low. The result is the elimination of all metallic friction, since the movements simply cause molecular deformation in elastic material. It has, therefore, been possible to replace bearings of normal design by rubber cones, the shape of which enables them to resist both vertical loads and longitudinal and transverse horizontal stresses. Rubber pads have also been used at the ends of the leaf springs in the primary suspension, as shown in Fig. 8, Plate XX. These rubber parts enable lubrication to be dispensed with and wear to be eliminated. They also increase the flexibility of the suspension and provide an amount of damping which is valuable. Periodical lubrication of the mechanical parts of the new locomotives is, therefore, practically unnecessary. All that is required is that oil and grease should be supplied where required during running and as part of the general overhaul. The number of inspections and, consequently, the maintenance costs, can therefore be greatly reduced. The reduced wear thus achieved ensures that the mechanical parts remain in good running order, so that general overhauls can take place at longer intervals and an exceptionally high utilisation factor be obtained.

### ELECTRICAL EQUIPMENT.

One of the advantages of the C-C axle arrangement is that it enables six motors to be used and their connections to be arranged so as to obtain an improved system of control. In fact, by supplying the motors at "half voltage" it is possible to employ three arrangements of connections to give

(To face page 642.)

# 4,800-H.P. 1,500-VOLT LOCOMOTIVE FOR FRENCH NATIONAL RAILWAYS.

(*For Description, see Page* 641.)

**Fig. 6**

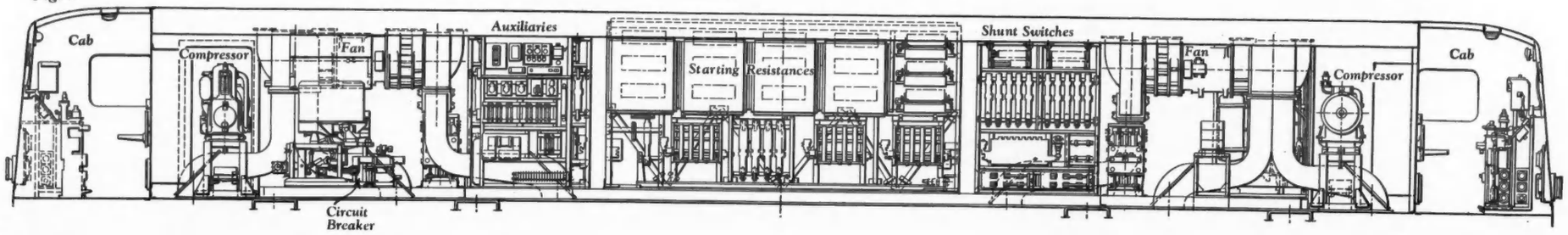
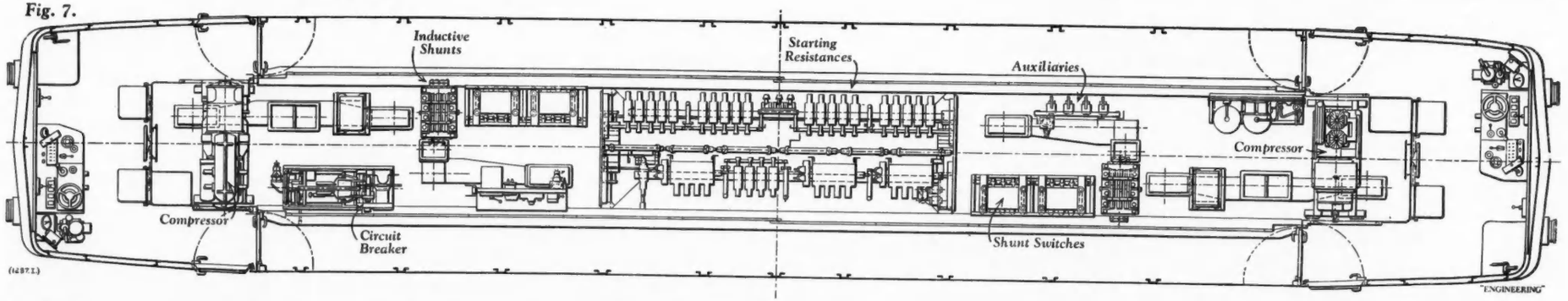



**Fig. 7.**



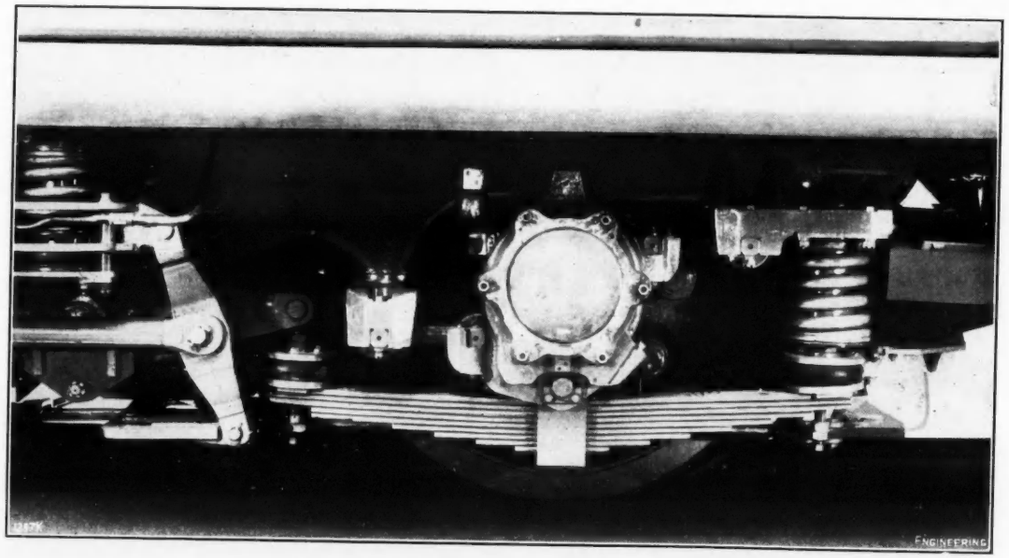




FIG. 8. AXLEBOX WITH SILENTBLOC MOUNTINGS.

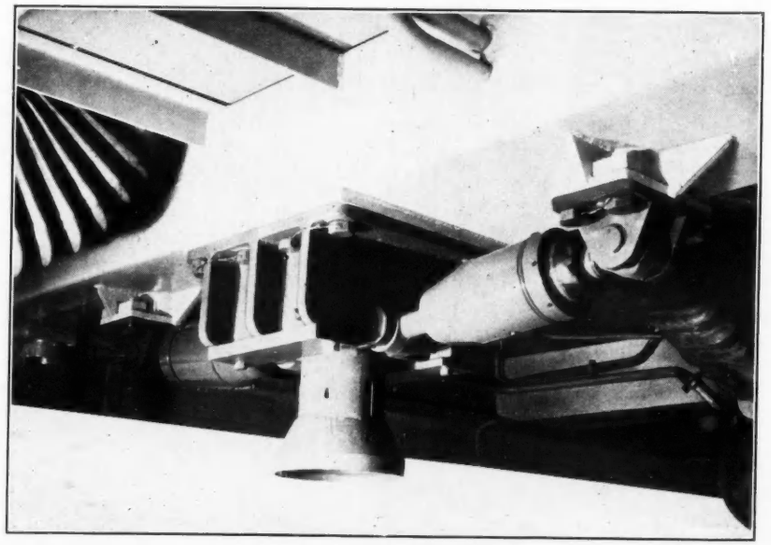


FIG. 9. BOGIE PIVOTING SYSTEM.

# 4,800-H.P. 1,500-VOLT LOCOMOTIVE FOR FRENCH NATIONAL RAILWAYS.

(*For Description, see Page* 641.)

*Fig. 10.*

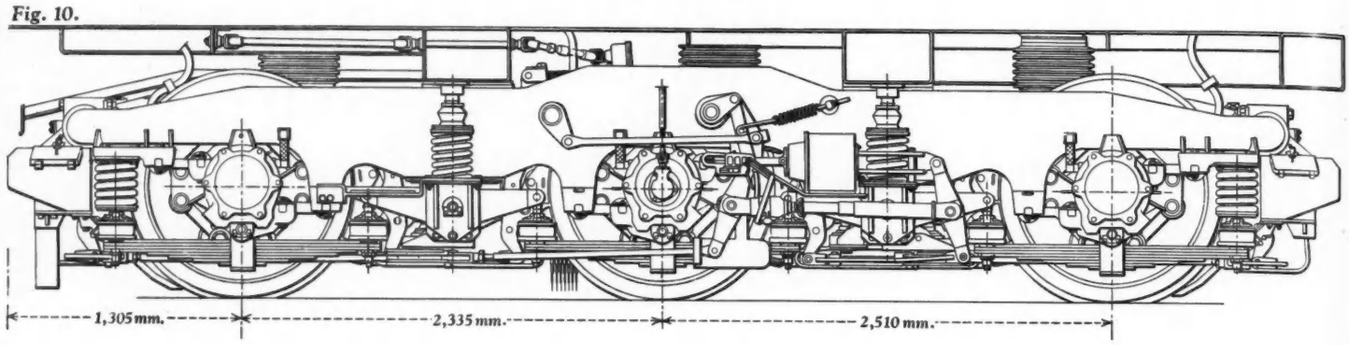



*Fig. 11.*

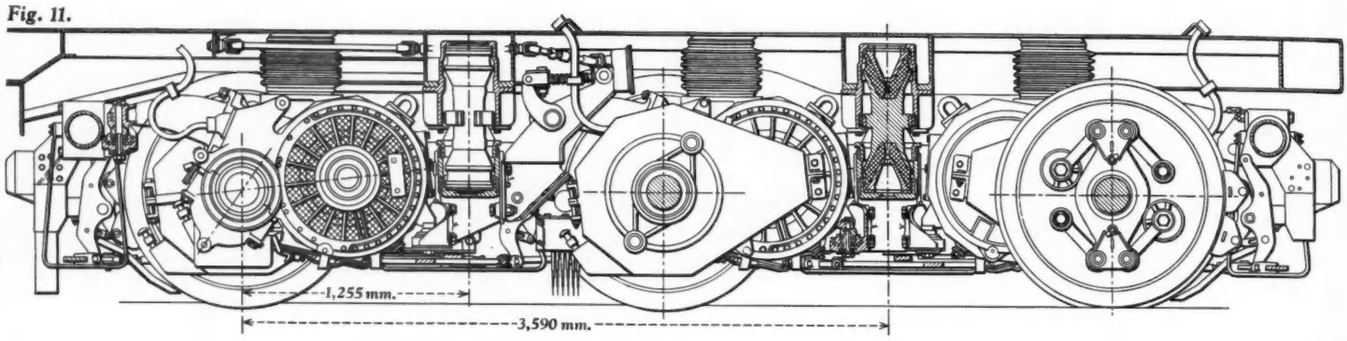



*Fig. 12.*

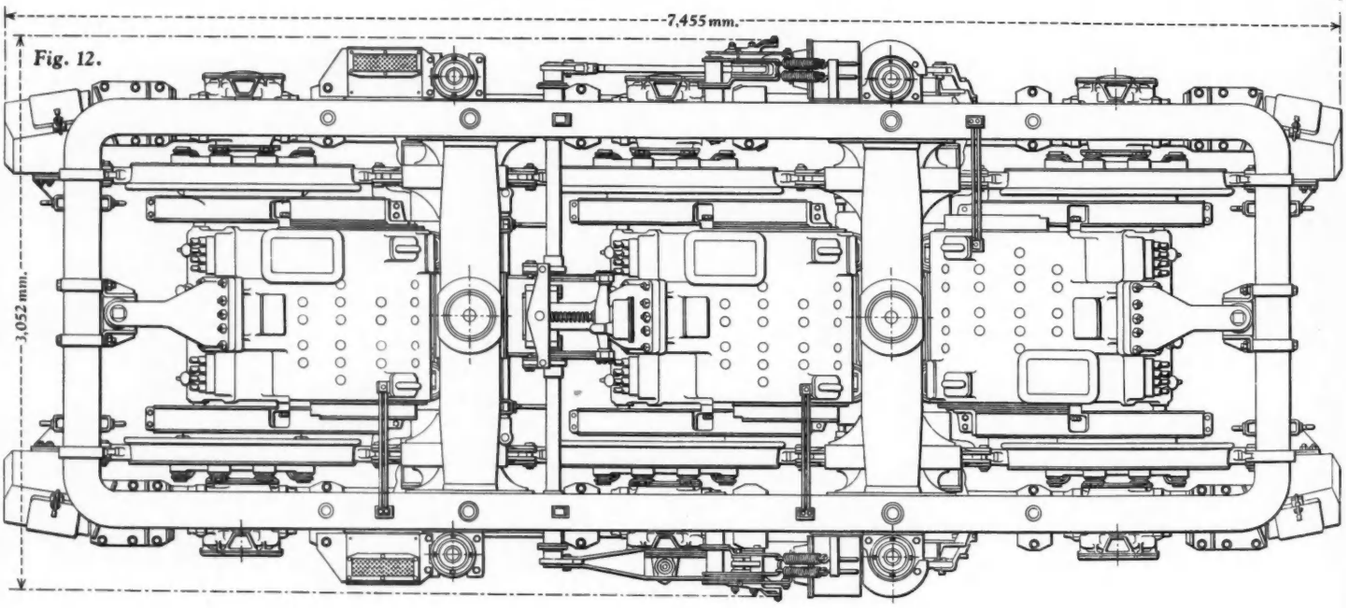



*Fig. 13.*

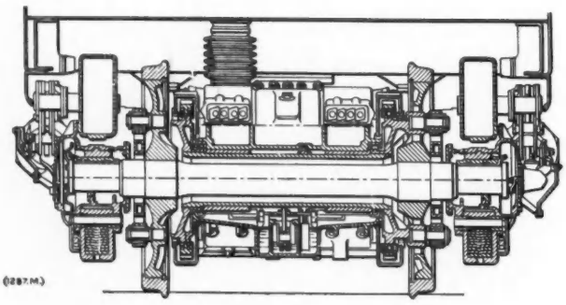
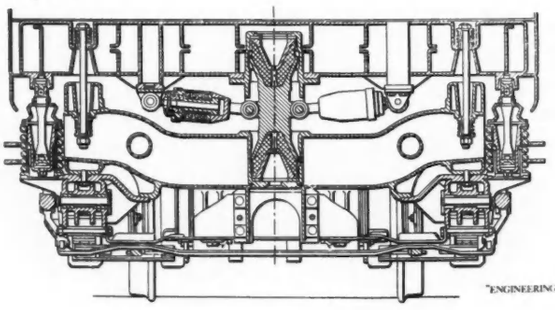


*Fig. 14.*




(*To face page* 643.)

# 4,800-H.P. 1,500-VOLT LOCOMOTIVE FOR FRENCH NATIONAL RAILWAYS.

Fig. 15.
STARTING CHARACTERISTICS AT 1,350 VOLTS.

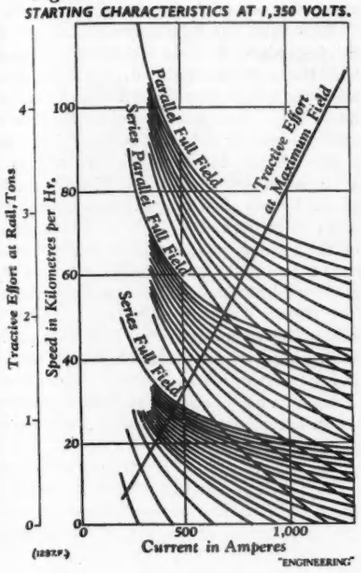



Fig. 16.
MOTOR CHARACTERISTICS AT 750 VOLTS.

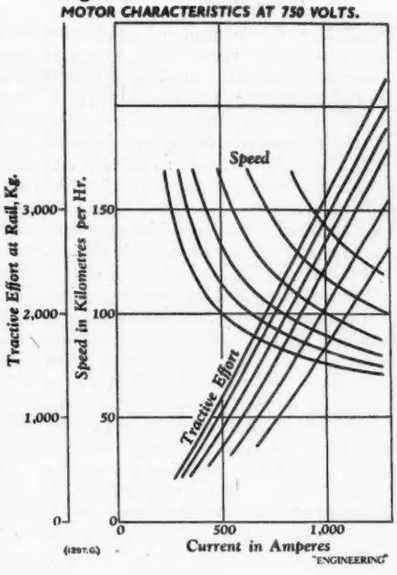
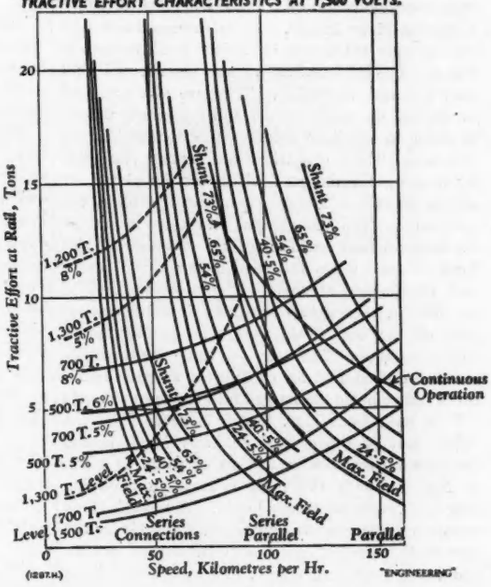



Fig. 17.
TRACTIVE EFFORT CHARACTERISTICS AT 1,500 VOLTS.



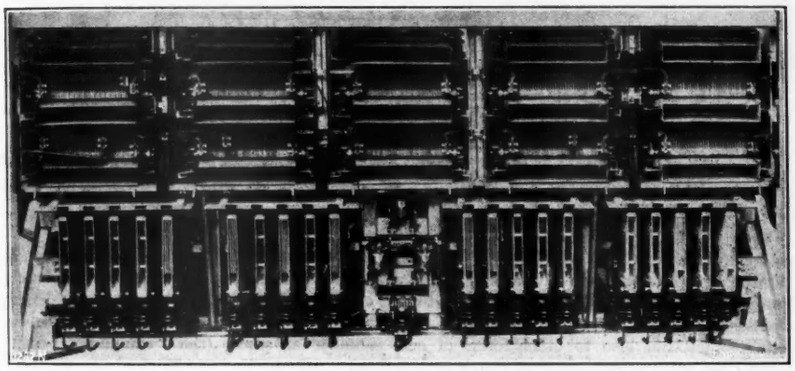



FIG. 18. CONTACTORS AND STARTING RESISTANCES.

speeds in the ratio of 1 : 2 : 3, with the result that the tractive-effort curves are regularly distributed over the working zone and there are no important "dead" spaces. If only four motors were used, however, the speed ratio would be 1 : 2 : 4, which is much less advantageous at starting, besides making the arrangement of the running notches less economical and giving poorer power distribution.

Actually, the motors on these locomotives can be connected in series, series-parallel or parallel. Under the first of these conditions all six motors are connected in series; in the second, two groups of three motors in series are arranged in parallel; while in the third three groups of two motors are connected in parallel. The control system provides 40 full-field notches—18 with the series, 12 with the series-parallel and 10 with the parallel connections—and enables a ratio of tractive to starting effort of less than 1·15 to be obtained. This is quite satisfactory, especially when the adhesion of the locomotive is taken into account. In addition, five balanced weak-field notches are available on all three systems of connection, thus enabling the resistances and inductive shunts to be used to reduce the fields by 24·5, 40·5, 54, 65 and 73 per cent. of their normal values. Five intermediate unbalanced notches are also provided for each type of connection. These are arranged on the Alsthom system, in which the absence of auxiliary contactors facilitates movement. The passage from one notch to another is effected by three groups of cam-operated contactors, while electro-pneumatic contactors are used for cutting out the starting resistances. The reversing switches are also operated by cams, which are driven by individual electro-pneumatic servo-motors. The remainder of the control apparatus is of standard pattern, but includes the most recent improvements.

## MOTOR DESIGN.

The traction motors are of the wholly-suspended type and, as already mentioned, drive the road wheels through flexible gearing, with a reduction of 2·606 to 1, and a quill shaft. They each weigh about 3¾ tons, and have been designed so that under the best conditions they can be employed to haul both express passenger and heavy freight trains on all the main lines of the French National Railways. They are provided with compensating windings and it is therefore possible, even when they are connected in parallel, to obtain a shunt ratio up to 75 per cent., and thus, as already mentioned, to provide a large number of control notches. Another feature of their design is that the upper layers of the armature coils have been "folded," in order to reduce commutator losses, while those in the lower layers have been made solid. The armatures are carried on roller bearings, so that lubrication between overhauls is unnecessary. The brush holders are mounted on an adjustable ring so that inspection is facilitated. The bearings carrying the quill shaft are supplied with oil from a gear pump, which is driven by a pinion on the shaft itself. As the oil is subsequently returned to a reservoir the consumption is very low. There is also an auxiliary lubricator on each bearing which comes into action on starting or if the pump should break down.

## OPERATING DATA.

Fig. 16 gives characteristic tractive effort and speed curves for an individual motor when operating at 750 volts. Fig. 15 shows the starting characteristics of the locomotive with a line voltage of 1,350 volts, and Fig. 17 shows the tractive effort of the locomotive under different switching conditions. An examination of the curves in Fig. 17 shows the smoothness of the notching and the complete absence of a dead zone between the series-parallel and parallel connections. This is due to the employment of half-voltage motors and the large number of shunt notches. Owing to the motors being compensated, the width of the zone covered by the economical working notches is unusually large and is the reason why a very high shuntage ratio can be obtained. Curves showing the tractive effort required to haul 500 metric ton and 700 metric ton passenger trains on the level as well as on 5 per cent. and other gradients; 1,300 metric ton freight trains on the level and on a 5 per cent. gradient; and 1,200 metric ton trains on an 8 per cent. gradient are also given in Fig. 17. From these it will be seen that both 500 metric ton and 700 metric ton passenger trains can be hauled on the level at a speed of 94 m.p.h. without employing maximum field weakening and without exceeding the maximum continuous rating of the motors. Freight trains of 1,300 metric tons, or 1,200 metric tons, can also be hauled on gradients of 5 per cent. and 8 per cent. without the maximum continuous current rating being exceeded with series-parallel connections and full field. With maximum shuntage a 700-ton passenger train can be hauled at 100 m.p.h. on the level, at 87·5 m.p.h. on a 5 per cent. gradient, and at 82·5 m.p.h. on an 8 per cent. gradient, the line pressure in all cases being 1,500 volts. The performance of these locomotives is therefore comparable with that of the most powerful units which are being used on the French National Railways at the present time.

### AUXILIARY EQUIPMENT.

As shown in Figs. 6 and 7, Plate XX, the auxiliary equipment is installed in a central compartment of the locomotive, access to which is obtainable from two side corridors. These corridors, of which a view is given in Fig. 3, also communicate with the driver's cabs, one of which is illustrated in Fig. 4. The layout of the various units is such that they are very accessible. They are also arranged in blocks on frames with self-contained wiring, in order to facilitate erection and dismantling for overhaul. These operations are further simplified by openings in the roof which can be closed by sliding shutters. The two outermost wells in the roof support the pantographs and below them are the motor-driven ventilating fans. These wells also form compartments into which the air is drawn and transmitted thence to the motors. One of the fans in each group forces air into the central part of the body, which is consequently under slight pressure. The air is thus continuously renewed and is used for cooling the starting resistances before being discharged into the open air. As will be seen from Figs. 6 and 7, Plate XX, the upper part of the central auxiliary block houses the starting resistances, a view of which is given in Fig. 18, with the main contactors, reversing gear and overload relays below. A second block contains the pneumatic equipment and includes the air vessels, pressure regulators, auxiliary compressor and various isolating valves. As will be seen from Fig. 7, Plate XX, there is an electrically-operated compressor at each end of the central compartment adjacent to the driver's cabs. In the case of one group of locomotives now being constructed, these compressors will be of the three-cylinder two-stage type with an output of 2,000 litres per minute at 7·5 hectograms per square centimetre, while another group will be equipped with units of the two-cylinder single-stage type, with an output of 1,350 litres per minute at the same pressure.

The driver's cabs, a view of one of which is given in Fig. 4, are unusually spacious and great care has been taken to arrange the various apparatus in the most convenient manner, to provide maximum visibility and to ensure that the crew work under the least tiring conditions.

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GEORGE E. DAVIS MEMORIAL LECTURE.—The North-Western Branch of the Institution of Chemical Engineers has arranged a lecture in memory of George E. Davis, who delivered at the Manchester Technical School in 1887 the first course of lectures on chemical engineering. These formed the basis for his two-volume *Handbook of Chemical Engineering*, which was published in Manchester in 1901. The memorial lecture will be delivered by Mr. Norman Swindin, a former pupil of Davis, at the College of Technology, Manchester, on Saturday, October 10, commencing at 3 p.m.

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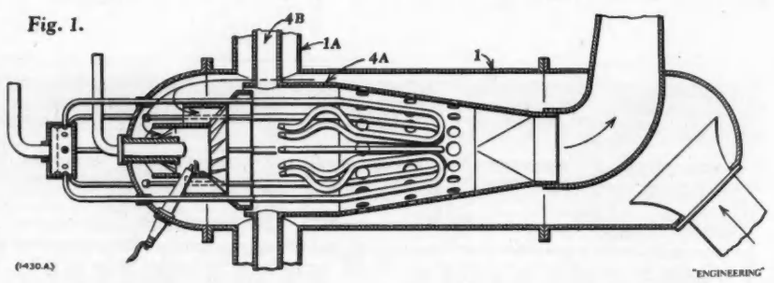
MULTI-PLATFORM LORRIES FOR BULK TRANSPORT.—An interesting vehicle body on a trailer has been made by Glover Webb & Liversidge, Ltd., Gashouse-lane, Hertford, for R. A. Main, Ltd., Gothic Works, London, N.18. Both are hardwood framed, and panelled in aluminium and aluminium Plymax and are reinforced to take a second floor (fitted 3 ft. 3 in. above the main floor) which is constructed in detachable sections for ease of loading and unloading, each section being supported on a strip of angle iron running along the interior of the body on both sides. The sections are made so that they slide easily along on the angle to the front of the body. Fitted at the rear of the body is a Burtonwood tailboard stacker which is cable operated and lifts from ground level up to the height of the second floor. To assist further with the unloading, detachable castors are fitted to the tailboard, so that, after lowering to the ground and releasing both the side struts supporting the tailboard, it can be wheeled away with the load on it, one of the side struts being used as a towing or manœuvring arm. A roller shutter pulls down to the top of the tailboard to cover the rear opening of the body, and doors are used for this purpose on the trailer. When fully loaded the body and trailer together can carry about 150 cookers or 2,250 meters, as compared to the normal load of 60 cookers or 1,000 meters. The maximum permissible payload is 12 tons 8 cwt.

## POWER JETS' GAS-TURBINE PATENTS.—VI.*

### COMBUSTION.

THE satisfactory development of combustion systems for gas-turbine plant, both aero and industrial, has necessitated the tackling of a great number of problems and the conception and investigation of a greater number of expedients; to name but a few, the problems involved have included those of attaining high combustion efficiency and high rates of heat release (with economy of weight and space in the aero case), of reducing pressure loss to a minimum, of achieving a high degree of mixing of hot gas and cooler air to provide uniform temperature distribution at turbine entry and of ensuring adequate flame stabilisation in a combustion zone past which air is flowing at a velocity very many times the speed of flame propagation. It is not surprising, therefore, that the combustion section in the Power Jets' patent holding is a large one and that it will be possible, in the space available, to review but a relatively small proportion of the patents which relate to combustion problems of one kind or another; in selecting patents for review, it may be necessary to omit some well worthy of special mention in order that a cross-sectional view may be given of the variety of problems which have been attacked. In Section II (Thrust Augmentation, page 516, *ante*) there have already been reviewed some patents concerned with inventions applicable not only to afterburning in a propulsive jet, but also to other forms of combustion; as will be seen, some of the inventions to be reviewed below are also applicable to the solution of problems arising in connection with afterburning.

Fig. 1.




Once again, a Whittle patent heads the chronological list of cases for review, the number being 577,972. The decision having been made (at the second re-build of the experimental engine mentioned earlier under the designation WU) to use a number of individual combustion chambers, it became necessary to ensure that all chambers lit up more or less simultaneously (thereby avoiding serious temperature variations around the turbine entry) and that pressure was equalised as between individual chambers. As illustrated by Fig. 1, pairs of nested "interconnector" pipes 1A and 4B were provided between adjacent pairs of combustion chambers to connect together the air casings 1 and flame tubes 4A thereof respectively. In the photograph of the second re-build of WU (Fig. 2, opposite), outer pipes, equivalent to those shown at 1A in Fig. 1, can be seen spanning between the rear ends of the air casings of some of the pairs of combustion chambers; similar indication of "interconnection" may be observed in a large number of current designs of the "multi-can" type (as multi-combustion chamber engines are colloquially known). In addition to ensuring substantially simultaneous lighting-up in all chambers, interconnection makes it possible to dispense with igniters in most of the chambers; furthermore, the equalisation of pressure as between individual chambers tends to prevent compressor-surging which might otherwise occur if the fuel flow through individual burners or vaporisers should vary to any great extent.

Known, after one of the inventors, as the "Lubbock" flame tube, the tube shown at 1 in Fig. 3, opposite, (reproduced from the specification of Patent No. 583,211) is of a type introduced, in 1940, to replace the vaporising system previously used in the second re-build of WU. Fuel is sprayed into the tube at the upstream end by a burner 3 and primary air enters the tube at the same end by way of a swirler 4; secondary air is admitted substantially tangentially by way of ports 6, which are so arranged in relation to the swirler 4 that local reversal of flow of the gaseous products is caused and combustion is substantially completed between the two points of air admission. Dilution air may also be admitted farther downstream by way of pipes 8 and ports 9. The drawing shows the tube arranged in an air-casing 2 of the reverse-flow type used in WU and later Power Jets engines; subsequently, the Lubbock flame tube has found some considerable flavour in combustion chambers of the straight-through type.

The "multi-can" type of combustion system, to which the previous patents related, retains the popularity which it has enjoyed since the early stages of development of the Power Jets engines; many current axial-flow aero engines, however, are of the type comprising a single annular combustion chamber (the "annular" type) or that comprising a number of separate flame tubes in a common annular air-casing (the "cannular" type). The next patent, No. 595,831, relates to this latter system and has several important features; one of these is illustrated by Fig. 4, opposite, which represents a bi-planar section through an annular air-casing 27 containing a number of generally cylindrical flame tubes (see reference 11 in lower half of drawing). The flame tubes are partly obturated at their upstream ends and at their downstream ends their circular cross-section merges smoothly into a sector-wise form (see reference 26 in upper half of drawing), which facilitates nesting together at the nozzle box of a turbine or in an annular duct in which it may be required to burn fuel in the air stream delivered by a ducted fan.

While not directly concerned with the actual flame zone of the combustion system of a gas turbine, the invention according to patent No. 598,947 relates to a device for effecting intimate mixing together, downstream of such a zone, of hot products of combustion and relatively cold dilution air. Known colloquially (and for obvious reasons) as the "Daisy Mixer," the device comprises nested ducts 1 and 2 (see Fig. 5, opposite), which lead into a common mixing chamber formed by a continuation of the outer duct 1. The portion of the inner duct immediately adjacent the mixing zone is formed by a flared member of which the wall is corrugated to provide interdigitated inner and outer passages 4 and 5, respectively. The arrangement is such that cold air from the outer duct 1 flows through the passages 5 to mingle with hot gas flowing through the duct 2 and passages 4.

Many patents relate to the provision of flame-

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* Part V appeared on page 609, *ante*.

# POWER JETS' GAS-TURBINE PATENTS.

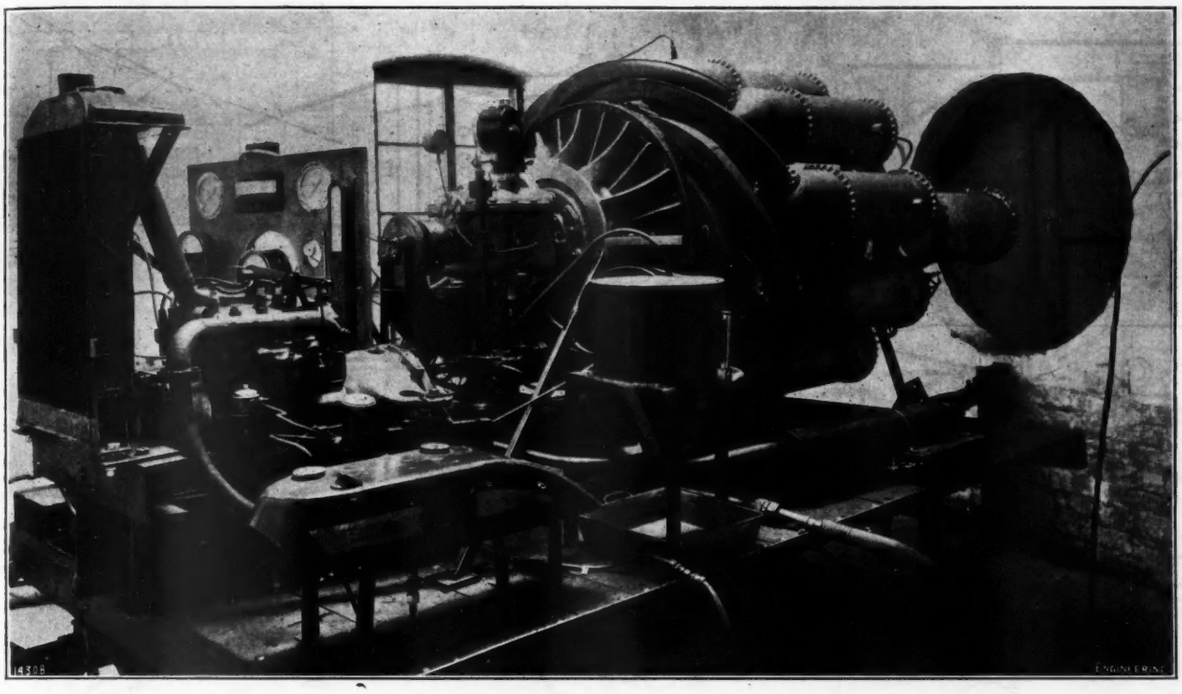


FIG. 2. REBUILT WU ENGINE, SHOWING INTERCONNECTOR PIPES.

Fig. 3.

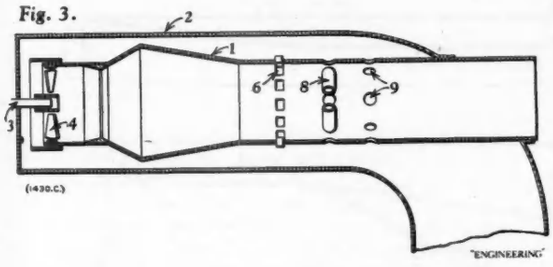



Fig. 4.

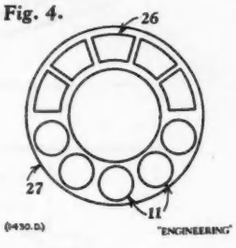



Fig. 5.

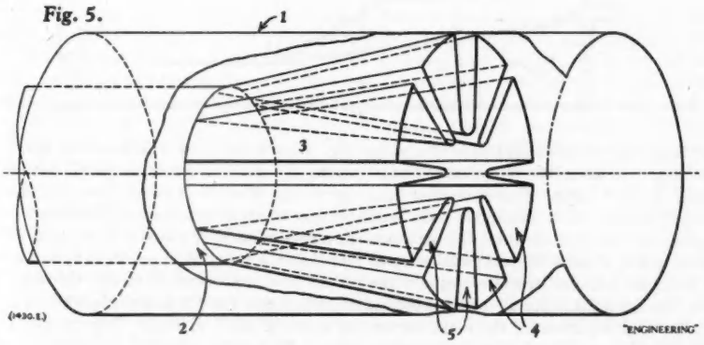
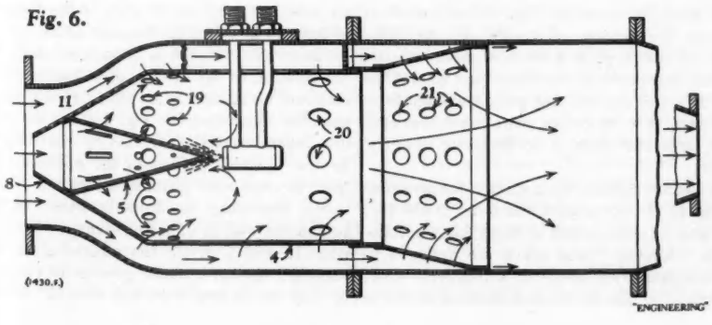



Fig. 6.




stabilising baffles in combustion chambers through which air is to pass at speeds greatly in excess of that of flame propagation. One such patent is No. 599,257, which has already been reviewed in Section II Thrust Augmentation (Afterburning). As stated in the earlier review, the invention according to that patent is applicable both to afterburning and to the main (i.e., pre-turbine) combustion system of a gas turbine. Patent No. 620,343 is concerned with the incorporation of features of the earlier invention in a modified form of main combustion system of either the "multi-can" or "cannular" type; one object of the invention was to avoid the length-penalty involved in the use, upstream of a combustion system, of a diffuser designed to reduce air velocity to a value such that stable combustion is possible. As shown in Fig. 6, the air-flow from a compressor is divided by the wall 8 of the partly obturated upstream end of a flame tube 4, into an outer, annular stream which goes to a diffusing passage 11 and a central core which passes axially into the interior of a perforated conical baffle 5. Fuel is injected in an upstream direction toward the apex of the baffle and the diffused air can enter the flame tube, as secondary air for mixing with the products of combustion, by way of ports 19, 20 and 21.

Patent No. 638,070 is also concerned with the attainment of adequate diffusion before combustion, combined with economy of weight and axial length. Fig. 7, page 646, depicts a "cannular" system in which air passing to flame tubes 15 (of which one is shown in section in the upper half of the drawing and another in outline in the lower half) reaches the interior of a common air-casing by way of trumpet-shaped diffusers 22A discharging down stream of the upstream end of the flame tubes.

The fact that the application for patent No. 639,468 was filed in 1947 is evidence that, from an early date in its history, the National Gas Turbine Establishment has been concerned with the industrial gas turbine as well as with its aero counterpart. The invention is concerned with combustion chambers of the vortex type in which an air-stream,

# POWER JETS' GAS-TURBINE PATENTS.

Fig. 7.

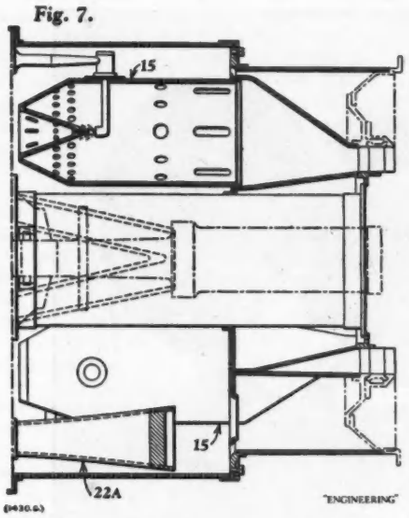



Fig. 8.

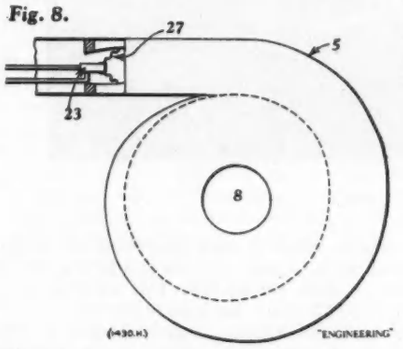



Fig. 9.

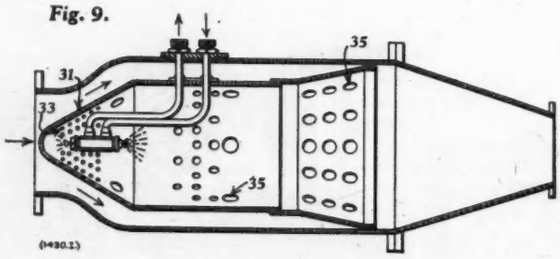



Fig. 10.

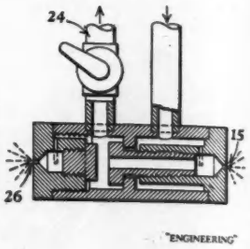



Fig. 12.

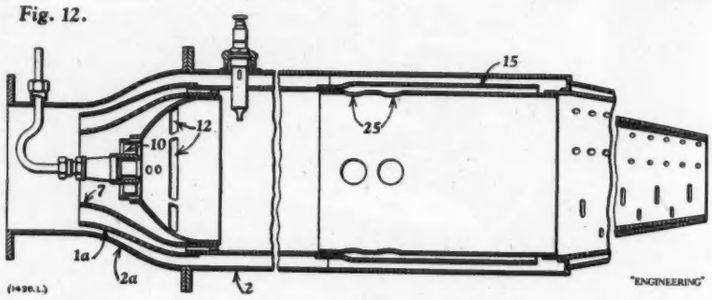



Fig. 13.

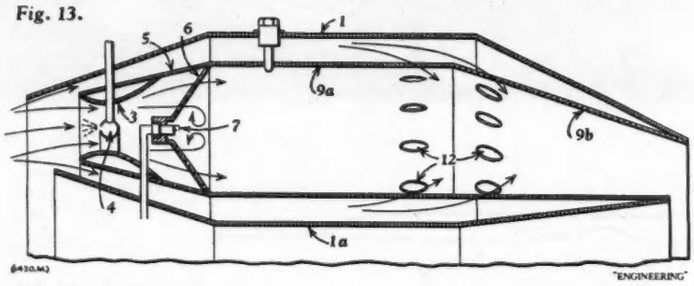



Fig. 11.

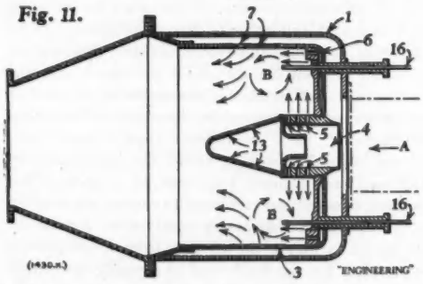
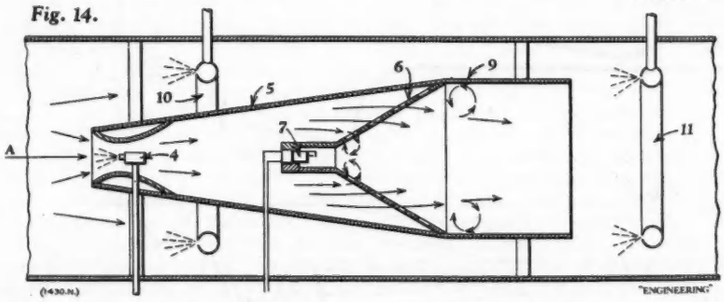



Fig. 14.




having a vortex motion with a relatively high radial velocity, interacts with particles of solid or heavy liquid fuel which are suspended, with relatively low radial velocity, to move in an equilibrium path determined by the centrifugal forces acting upon them in opposition to the forces applied to them by the vortex flow. As represented by Fig. 8, a combustion chamber in accordance with the invention is of circular section with an axial outlet 8 of diameter substantially smaller than the maximum diameter of the chamber and to which the particles move progressively as their weights, and thus the centrifugal forces acting upon them, decrease; air is injected into the chamber of way of a volute inlet duct 5 so as to receive a regular radially-inward vortex flow toward the outlet, and a baffle 27 is provided to form, within the air-stream, a zone of stabilised combustion of fuel ejected by a burner 23. Although this particular patent is the only one here reviewed which relates to the vortex type of combustion chamber, several other patent applications have already been filed in connection with the type.

Patent No. 647,344 is mainly concerned with the prevention of flame-extinction under widely varying conditions of air mass flow and density, to which end a pilot burner is provided upstream of a main burner, the supply of air to the region of pilot fuel supply being limited. Fig. 9 shows pilot and main burners housed in a common body and mounted within a flame tube of which the upstream end comprises a conical baffle 31 perforated as at 33 to provide restricted inlet for air to the region of the pilot burner, the main inlets for air being provided by larger holes 35 downstream of the main burner. The burner assembly employed may conveniently be of the kind illustrated by Fig. 10, and which in itself forms the subject of patent No. 647,399; this is of the spill type and the flow characteristics of the main (downstream) discharge port 15 and the spill line 24 are so related that pilot discharge from the upstream port 26 occurs even when the spill rate is so large that there is no discharge from the main port.

Patent No. 650,528 has been selected for review as representative of two patents (the other is 650,462) which relate to combustion systems known colloquially as "toroidal" and which are designed to achieve complete combustion in a relatively short axial length. In the combustion chamber shown in Fig. 11, a flame tube 3 is mounted within an air-casing 1, which receives air as indicated by the arrow A. Fuel is injected into the flame tube by way of an annular series of nozzles 16, situated in a region where a toroidal whirl of air-flow, indicated by the arrow B, is produced by the interaction of air jets introduced from the air-casing by way of ports 6 and 7 in the flame tube wall and of ports 5 in a centre piece 4, which projects into the flame tube. To ensure complete combustion, additional air is introduced into the core of the flame by way of ports 13 in a conical extension of the centre piece.

Patent No. 636,624 is chosen as an example of one relating to the cooling of a flame-tube wall by means of an insulating air film. In the combustion chamber illustrated by Fig. 12, the air is divided into separate coaxial streams by coaxial partitions 1a and 7, which project in the upstream direction from the upstream (primary-zone) end of the flame tube. Secondary air flows between the partition 1a and the wall 2a of the air-casing, while the partitions 1a and 7 divide the remaining air into two streams; the inner stream goes to the primary zone, by way of the swirler 10 and slots 12, while the air

# POWER JETS' GAS-TURBINE PATENTS.

Fig. 15.

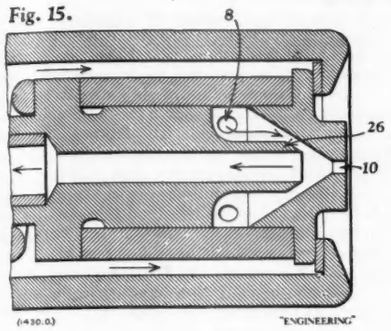



Fig. 16.

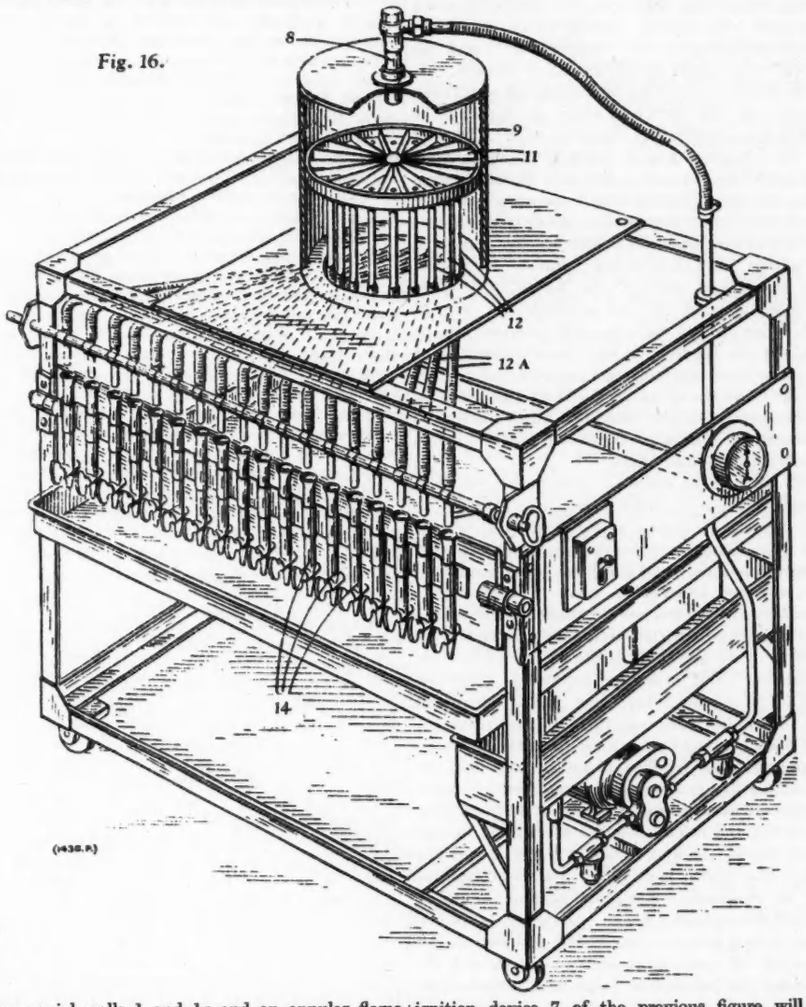



Fig. 17.

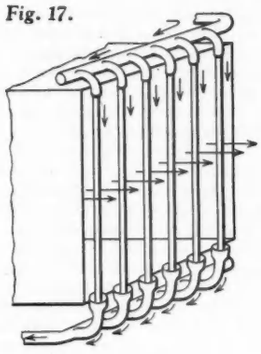
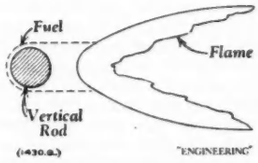


Fig. 18.




passing between the two partitions forms a film of cooling air flowing along the inner face of the flame-tube wall and insulating it from the hot gas produced in the primary zone. The arrangement is such that the velocity and direction of flow of the cooling film approximate to those of the hot gas in the primary zone, the film forming a separate non-turbulent flow extending downstream a distance at least equal to the diameter of the flame tube. If it is desirable for the insulating effect to be extended farther downstream, further films of cooling air may be introduced at intervals along the flame tube; this may be achieved, for example, by the provision of axially-directed, annular bleed passages by which air is admitted from the annular space between the air-casing and the flame-tube. Fig. 12 does not show bleed passages such as those just referred to, but it does illustrate another optional feature, which in itself forms the subject of another patent (No. 636,623). This further optional feature is the provision of a wall 15 surrounding the ports 25 by which the secondary air reaches the interior of the flame tube; before gaining admission, the secondary air is caused to flow back along the outside of the downstream end of the flame tube, thus exerting a cooling effect on that portion of the tube.

Although the specification of patent No. 684,669 includes drawings illustrating ram-jet and after-burner constructions, the invention is said to be capable of particularly advantageous application to shapes of combustion chamber not possessing circular symmetry with respect to the path of the air flow; such an application is illustrated by Fig. 13, opposite, which represents a part-section through an annular combustion chamber. The combustion chamber comprises an annular air-casing defined by the coaxial walls 1 and 1*a* and an annular flame chamber 9*a*, 9*b*. Some of the air entering the air-casing flows round the upstream end of the flame chamber, the remainder entering the latter by way of a throat 3, which is followed immediately by a diffusing and mixing passage 5; fuel is injected in the upstream direction by a ring of nozzles 4 and the fuel and air become thoroughly mixed before passing through perforations in a conical baffle 6. The small jets of fuel-air mixture passing through the perforations set up standing eddies (as indicated by arrows) so that a stabilised flame zone is formed in the wake of the baffle. An ignition device 7 is provided in the stabilised zone and, the air velocity upstream of that zone being considerably in excess of the speed of flame propagation, there will normally be no combustion upstream of the baffle; holes 12 are provided in the walls 9*a* and 9*b* of the flame chamber to provide paths, from the interior of the air-casing, for air required for completion of combustion and dilution.

Although the arrangement illustrated by Fig. 13 provides for injection of all the fuel into the air flow upstream of the stabilising baffle, several of the arrangements described in the specification of the above patent are such that only pilot fuel is so injected, as in the case of the arrangement illustrated by Fig. 14, opposite. This figure also illustrates the next patent, No. 684,670, and depicts a combustion system which is intended primarily for use in a ram-jet wherein the ducted airstream due to flight is in the direction indicated by the arrow A. The diffusing passage 5, flame-stabilising baffle 6, and ignition device 7 of the previous figure will be recognised; in this case, however, the injector 4 supplies only the fuel required to maintain a pilot flame in the stabilised zone. The main body of fuel is supplied in two stages by way of rings of jets 10 and 11, all of which are directed in the upstream direction. The fuel supplied by the jets 10 is deliberately introduced with a markedly non-uniform distribution over the cross-section of the air-flow in order to avoid the formation of an explosive mixture in the region where the products of pilot-combustion are discharged at the end of the inner duct 9; the pattern of the supply from the jets 11 is made complementary to that from the jets 10, in the sense of rendering the flame intensity more uniform downstream of the outlet from the duct 9.

Deliberately taken out of chronological order is patent No. 653,626, which has been selected for review as representative of a number of patents concerned with burners suitable for gas-turbine combustion; it relates to a form of spill burner. Primarily intended to improve atomisation at low fuel-flow rates (e.g., under conditions of high-altitude flight), the invention may be adequately illustrated by the fragmentary section of the delivery end of a burner construction reproduced as Fig. 15. As shown, a tubular extension 26 of the spillway projects into the core of the vortex produced in the swirl chamber for such a distance that liquid which proceeds from the swirl ports 8, but does not become discharged by way of the outlet orifice 10, will have given up a substantial part of

its kinetic energy before flowing back along the spillway.

Also deliberately taken out of chronological order is patent No. 579,413, relating to an instrument which is known as the "Patternator" and has proved very useful in the testing of burners. As shown in Fig. 16, page 647, the instrument comprises a chamber 9, into the top of which the burner to be tested may be fitted as indicated at 8. The floor of the chamber has a number of upstanding, symmetrically-disposed radial ribs 11 which form a number of similar receivers; each such receiver is located beneath a particular sector of the burner orifice and each has a drain hole which is connected by a pipe 12, 12A to a glass burette 14. When fuel is pumped through the burner, the spray produced is caught by the receivers, the catch of each being led to the associated burette. If the levels in the burettes do not rise substantially at the same time, an indication is given not only of the fact that the spray produced by the burner is uneven but also of the manner in which the lack of symmetry of discharge is related to the various sectors of the burner orifice.

All the patents reviewed above relate to combustion systems of types which may be said, at this date, to be more or less orthodox. Power Jets have licensing rights in an interesting new system based on work currently being conducted at Cambridge University. None of the relevant patents has as yet reached the stage of publication; it is possible to say, however, that a basic feature of many of the inventions is the use of rods or other bodies of "bluff" section extending across an air-flow to provide a turbulent "wake" in which fuel, which has been vaporised at the surface of the bodies, may be burnt. This concept is illustrated diagrammatically by Figs. 17 and 18, page 647. In the former figure, a series of vertical rods is represented as being arranged across a duct carrying an air-flow; a header member is provided to lead liquid fuel to the upper ends of the rods and discharge it so that it flows down their outer surfaces. Fig. 18 represents a horizontal section through a rod and the associated flame. Advantages expected to be derived from the new system include those of reduction of combustion-chamber length and the provision of a non-radiant flame (with the attendant advantage of relatively low wall temperature).

## THE INSTITUTION OF NAVAL ARCHITECTS.

(*Continued from page* 629.)

THE second paper presented at the afternoon session on March 26, during the Spring Meeting of the Institution of Naval Architects, was by Dr. R. Weck, and dealt with "Fatigue in Ship Structures."

### FATIGUE IN SHIP STRUCTURES.

Few structures, said Dr. Weck, were entirely free from the possibility of fatigue failure, because most structures were subject to variations of loading; the risk of fatigue failure depended on the number and magnitude of the stress changes thus induced. The stress variations sustained by the parts of a ship's structure were of a sufficient magnitude, and occurred frequently enough to bring fatigue failure into the range of possibility, but whether, in fact, such failures did occur in ships was very difficult to ascertain; owners, accepting the need for occasional repairs, did not concern themselves greatly to ascertain whether they were rendered necessary by fatigue corrosion, or by some other circumstance beyond their control. The classification societies might be expected to have some data on the incidence of fatigue failures in ships, but in fact, it seemed that they had not. Dr. Weck then proceeded to consider the possibility of fatigue failure in redundant and non-redundant structures generally, and in welded and riveted ships, and summarised the tests carried out on full-scale assemblies, under the ægis of the British Welding Research Association's committee, of which Mr. James Turnbull, O.B.E., was chairman. They were undertaken to determine the effect on the fatigue endurance of different types of joints between plating and stiffeners, and of different types of joints in stiffeners.

The general conclusions reached were that, as fatigue failures might be expected to propagate fairly slowly and generally could be repaired at small expense, it would not be reasonable to alter design practice if the alterations were likely to lead to considerable added cost in building; for instance, it would not be worth while to use continuous welding everywhere merely because such welds were less liable to fatigue than intermittent welds. On the other hand, butt welds reinforced by straps might have less fatigue endurance than welds without straps, so that the omission of the straps might be a definite improvement as well as being cheaper. If the butt welds were insufficiently strong even under static loading, the remedy was not to add butt straps, but to improve the quality of the welding. Scalloped stiffeners, attached by intermittent chain welding, did not show up very favourably in the investigation. While it was possible that a different form of scallop might give better results than those tested, they could be justified only if their use enabled appreciable savings to be made in deadweight and in cost, unless the possibility of fatigue failure were entirely ignored.

### DISCUSSION.

Mr. James Turnbull, O.B.E., who opened the discussion, said that the Institution was very fortunate to have a paper from one who was considered to be the leading authority in the United Kingdom and perhaps abroad on the subject of fatigue. Thinking on that subject had been very muddled. Those who were not learned in the matter naturally asked "What are fatigue conditions?" The author had answered that question in his preliminary remarks and it was to be hoped that he would include the answer in his written reply. There was much confusion because people talked very broadly about fatigue in ships and did not take the trouble to mention whether they are speaking of fatigue in panels of shell plating, in a stiffener, or in the whole hull structure. Fatigue in panels of plating in the panting area of ships' structures was undoubtedly experienced quite often some years ago, but, largely as the result of alterations in the design of the structure, that trouble was now rare. He did not think, therefore, that fatigue in such panels of plating need cause any concern in considering the subject; neither was trouble experienced as a result of fatigue in the stiffeners of a frame to any serious extent. The other main item in respect of fatigue was in the bending forces to which a ship was subjected, and in that connection he was not certain whether or not fatigue was important. A new welded ship was not made like a precision instrument; she might suffer stress in the region of a hatchway, but between the hatchway and the sheer strake there was a certain amount of "give." He thought that, when a ship went to sea and, for the first time, experienced fairly severe forces at the hatch corners and similar discontinuities, the material flowed plastically and there was a certain re-adjustment of the structure. Subsequent applications of reversals of load might cause fatigue failure, but of that he was not quite sure. So far as he was aware, no research into fatigue had been carried out on the material in the strained condition. Research on that matter would help to show whether or not fatigue was important in a ship's structure. He invited Dr. Weck's views on that possibility.

Dr. Weck admitted that he was not a naval architect, but he stated in the paper that "If one set out, for instance, to modify the design of the hull so that the probability of fatigue failure was very small, the cost to the industry would undoubtedly be a multiple of the cost of repair of such failures." A shipowner who ordered a ship from a shipbuilder was entitled to expect one that would not fracture in service. The author talked about allowing the cracks to occur and repairing them as they occurred, but it was not only the cost of the repair that had to be considered; probably the biggest expense was the loss of earning power. Ships must be designed so that they would not fracture in service. That could be done without resorting to special and expensive measures, merely by taking normal care in the detail design of the structure. Dr. Weck stated that "The classification societies might be expected to have data on the incidence of fatigue failure in ship structures, but, in actual fact, I believe, they have not," and went on to say that possibly fatigue failures were not recognised as such. Dr. Weck must know that he (Mr. Turnbull) would not say that. The staff of Lloyd's Register were fully aware of the difference between fatigue and brittle fractures, and, while attempts were made to ascertain the nature of fractures experienced, it was seldom possible.

He wished to thank Dr. Weck for referring to his part in the investigation reported in the paper. Dr. Weck had given the impression that he thought fatigue was very important indeed; Mr. Turnbull had been inclined to the opposite view, but could not make up his mind. It was originally intended that Dr. Weck and he should write the paper together but he was reluctant to write a paper without being quite sure about what he wanted to write. However, there was no one with whom he would rather collaborate in such a work than Dr. Weck.

Mr. D. E. J. Offord said that those who had visited the British Welding Research Association's laboratories at Abington would admire the work that Dr. Weck had done there, and the ingenious use he had made of the principles of resonance. He was in full agreement with Dr. Weck's two main conclusions, namely, that continuous fillet welds were undoubtedly to be preferred to intermittent welds, and that the low hydrogen electrodes gave results much superior to those obtained with the normal rutile type. Those were very important findings, to be commended to all who were dealing with the design of highly-stressed welded structures. He could not, however, entirely agree with the author in his discussion of the incidence and importance of fatigue failure in ships' structures. No doubt, someone from the shipbuilding firms would comment upon the statement that, after a few years, a builder's interest in his product became somewhat platonic; whatever the position might be in merchant-ship yards, that statement certainly was not true, so far as the Naval Construction Department was concerned, in the case of warships. An active interest was taken in the ships right up to the day they are disposed of for scrap, which was often many years more than their normal expectation of life. So far as the main strength structure was concerned, he had never come across a failure which could be attributed to fatigue caused by fluctuations in main longitudinal stress. If, therefore, the author meant the main strength structure, he could not agree that "the stress variations sustained by the different parts of a ship's structure during its useful life are certainly of a sufficiently high magnitude and occur frequently enough for fatigue failure to become possible." Recent measurements with strain gauges did not support that contention. Fatigue failures might occur in certain parts of structures other than the main strength structures; there might be fatigue failure, of course, in badly-designed structural supports to imperfectly balanced high-speed machinery, and sometimes in panels of bottom plating near the fore end of long ships, due to the variation of stress caused by pitching motion. Those were probably corrosion-fatigue failures, and he thought that the corrosion was the more important of the two elements.

Dr. Weck suggested, and not more than suggested, that some of the brittle failures which had occurred in ships might be due to fatigue cracks. The great majority of the serious brittle failures which had taken place in ships occurred very early in their life, long before fatigue cracks could have started in an otherwise satisfactorily designed structure; therefore he could not agree with the suggestion that fatigue might be a significant factor in brittle failures in ships. In other words, fatigue as such was not a problem in ships' main structures. However, that did not detract from the usefulness of the paper, which lay in the fact that Dr. Weck had developed a technique by which various pieces of structure could be tested under various conditions

of loading, enabling the designer to discover points of weakness and positions of stress concentration. The fatigue cracks were, in fact, serving the functions of strain gauges. A great deal more might be done with that technique. He asked whether Dr. Weck had thought out a practical scheme of resonant or cyclic loading which would be more representative of the stress distribution in, say, the strength deck of a ship.

Mr. G. M. Boyd observed that the main theme of the paper was that, while fatigue might be the cause of many of the small cracks which occurred in ships' structures, the cost of preventing them by refinements in design would be greater than the cost of repairing the cracks. While that was generally true in principle, it was obvious that the aim should be to design structures which would not fracture, even by fatigue. That aim was of particular importance in relation to the recent prominence of the problem of brittle fracture, since similar measures, such as avoiding notches, etc., served to reduce the liability to both types of fractures. As the author said, there was little information to establish what proportion of ship fractures was in fact, due to fatigue. The difficulties in obtaining information were formidable. In most cases, the cracks had to be repaired without delay, and, therefore, could not be opened up for examination. Moreover, the surfaces of the fractures, more often than not, were so rusted that the characteristic texture could not be distinguished. Again, owing to the working of the ship, the cracks tended to open and close, and in that process the original texture was liable to be damaged or obliterated. Incidentally, crushing of the fracture surfaces might be responsible for the characteristically smooth appearance of true fatigue fractures. There could be little doubt, however, that many of the small cracks at stress concentrations were due to fatigue. A good example was the type of fracture which used to occur at the caulking edges of riveted overlap butts, which were due, no doubt, to the high local bending stresses at those points, combined with possible surface damage due to caulking and corrosion. An examination of the reports on that type of fracture in an old ship, built in 1907 and still afloat in 1946, indicated a tendency for such fractures to recur at intervals varying from seven to 15 years.

Information was also scanty on the number of extensive brittle fractures which originated from fatigue cracks, but the proportion did not seem to be great. While some of the origin of such fractures had been found at pre-existing short cracks, the majority were found at easily recognisable notch effects resulting from defects in design or workmanship. There was little available information on the numbers and magnitudes of the actual stress cycles experienced by ships, apart from some data collected by means of the "statistical strain gauge" fitted in the steamer Ocean Vulcan (now Cape Nelson), mentioned by Mr. Turnbull in his recent paper to the Institution. The collection of such information was continuing. The true value of such studies depended, of course, on the importance of fatigue in relation to the strength and safety of ship structures. It was doubtful whether that question would be answered definitely within the foreseeable future. The topical value of the paper lay in its relevance to the problem of brittle fracture, particularly in welded ships. The role played by fatigue in that problem was by no means clear, but it was relevant, particularly in view of the author's observation that fatigue cracks were more liable to occur in welded than in riveted structures. A fatigue crack was probably the most severe "notch effect" conceivable, and therefore such a crack would be a menace if the material in which it occurred were in a notch-brittle condition. From that point of view, it was clearly desirable to devote particular attention to the detail design at critical positions, such as hatchway corners, to minimise the possibility of fatigue cracks. At the same time, such attention reduced the liability to the initiation of brittle fractures, even in the absence of fatigue. The part of the paper dealing with the experimental work on stiffeners was of particular interest, and the principles which emerged from those experiments were clearly of wide applicability.

Mr. L. G. Stevens thought that Dr. Weck had skated rather lightly over the problem of fatigue in relation to brittle fracture. He started by saying that fatigue was possible, then referred to the initiation of brittle fracture and, at the end, said that he did not bother much about it, anyway. Mr. Stevens did not think that there was much cause to worry, for the reasons that Mr. Offord had given; but, if there were any real danger of fatigue cracks initiating brittle fracture, no amount of effort that could be devoted to its prevention should be overlooked. It was suggested that the cost of repair was less than the cost of prevention, but he thought that, in certain cases, it might be a great deal more. Incidentally, that emphasised the importance of the type of experiment that Dr. Weck had been carrying out. If those experiments could show, as they appeared to do, that, given good design and technique, the chances of fatigue were not very great, they were very valuable indeed. Specimens which Dr. Weck had tested were subjected to a stress of $\pm$ 8 tons per square inch, mostly; but, at the points where failure occurred, the stress was probably of the order of $\pm$ 2 tons per square inch, or even less. The fatigue life he had given for good joints seemed to be greater than the number of occurrences of such stresses in ships at sea.

Mr. B. N. Baxter considered that the stress range chosen was too high, bearing little relation to the actual stress range met with by the main hull-girder of a ship at sea, and gave tables of stress readings on vessels at sea which indicated that, even during very bad weather, the stress range was much smaller than the $\pm$ 8 tons per square inch used in the experiments. The resonance vibration method used caused the specimens to vibrate with a frequency of 4,300 cycles per minute, or about a million loading cycles in four hours. With that very high rate it would appear practicable to use a smaller stress range since, even if 100,000,000 cycles were needed for fracture, these would take only about 16 days. A hundred million cycles might well be the total number of cycles experienced by a vessel in 30 to 40 years' service. Though it was apparent that, considered statistically, the main hull-girder of a vessel was in no danger from failure by fatigue, full-scale strength experiments had shown clearly that the local stress concentrations gave much higher stresses than those in the main hull-girder. At those points of stress concentration, therefore, any local failures should be investigated, the possibility of fatigue failures being kept well to the fore.

Professor E. V. Telfer said that, from time to time, he had been asked, in cases of heavy-weather damage, what fatigue was, which was a most difficult thing to decide when examining structural breakdown of ships which conceivably had been caused by heavy weather. It was never quite certain how far heavy-weather damage extended, and when cracks were found which had not been seen before, there was a tendency to regard them as heavy-weather damage. On the other hand, an underwriter's surveyor would say that they were probably due to fatigue, continuing for a long time. On behalf of the owners, he had tried to say that heavy-weather damage could not be divorced from the incidence of fatigue; and, when damage was found at a particular stage in a vessel's life, the chances were that the fatigue was first made possible by the incidence of heavy-weather damage which was unnoticed at the time. If there were cracking at a hatch corner, for example, it was probable that there had been very heavy fatigue loading for a short while, and the steel "remembered" that adverse experience in early life. He would be pleased to have an independent view of that from Dr. Weck, for it was one of the most important matters from the standpoints of owners and underwriters.

Dr. H. G. Taylor, of the British Welding Research Association, said that the work dealt with in the paper had extended over a fairly long time. It might not be very pertinent to present problems, but some day it might be found that fatigue was more serious than had been supposed. Further, the experiments probably had an application outside the shipbuilding industry. It seemed to him that the conclusions reached were that continuous fillets were better than the intermittent, that staggered fillets were better than chain fillets, that scallops reduced fatigue strength, that butt straps did not increase endurance, and that good results were obtained with low-hydrogen electrodes. It was often said, after a research, that the results were such as should have been decided beforehand. He was sure that Dr. Weck's conclusions could not all have been foreseen in that way, and that the results would stand for a very long time.

Dr. Weck, in reply to Dr. Taylor, said that he had put forward the conclusions with extreme diffidence and anxiety, because he could see how many divergent views there could be. The question whether there was a possibility of fatigue failure in consequence of the high stress in the main strength deck had been answered by Mr. Offord, who said that he had never seen a fatigue failure in the main strength structure of a ship. If they had not occurred, they were not likely to occur unless the classification societies introduced new regulations and reduced scantlings. It was said that the alternating stresses to which a ship was subjected in a seaway were not nearly so high as those applied in the tests. It should be remembered that he was working for a committee who were spending a lot of money and wanted results; he considered that 8 tons per square inch was reasonable, particularly for comparative purposes. When fatigue failure proper, in the sense he had mentioned, was produced by millions or hundreds of thousands of cycles, and different designs were compared, it did not matter much whether the comparison was made at 10, 100 or 1,000 million reversals; the results would be of the same order. The point was made that fatigue failures were comparatively rare. He had stated that only by opening up a failure and inspecting it under the microscope could it be seen definitely whether the failure was due to fatigue or not. He did not mean to imply any reflection on the ability of surveyors to determine the cause of cracks. What he had in mind was that, if inquiries were made of eminent people connected with the classification societies, no definite information could be obtained on how many fatigue failures there had been per annum in particular classes of ships. He had asked that question from time to time, but had been told that there were no failures. The question of corrosion-fatigue did not introduce a new factor. The only difference between ordinary fatigue and corrosion-fatigue was that, when fatigue occurred in the presence of a corrosive medium, it did so at lower stress, or the life might be shorter at a given stress.

An extremely interesting point was raised by Professor Telfer. Dr. Weck thought that his argument was basically correct, that the material "did not forget," and that, if a fatigue crack appeared, it might be considered as being heavy-weather damage, because fatigue failure was not found as the result of the number of cycles that a ship experienced at the low stress ranges in the ordinary way during its lifetime. It had been said by Mr. Boyd that anything which was apt to reduce fatigue failure was also apt to reduce the risk of brittle fracture. He could think of at least one important case where a brittle fracture was more liable to occur in a structure which was less liable to fatigue; it arose in connection with the use of thick plate. A thick plate could be built up from thinner plates by welding them along the edges, and that procedure would certainly reduce appreciably the risk of brittle failure. If a brittle crack were started in one place, it might not extend to the other places. With regard to fatigue, however, the mere fact that the plates were welded together meant that stress concentrations were introduced, and unless the whole assembly could be machined afterwards, which no one would dream of doing, it might be liable to fatigue failure. On the whole, however, he thought that Dr. Telfer's statement was substantially correct.

*(To be continued.)*

SOUTHERN JOINT BRANCH I.N.A. AND I.MAR.E.—The Southern Junior Branch of the Institution of Naval Architects and the Institute of Marine Engineers has been dissolved and replaced by the Southern Joint Branch, which embraces all grades of membership of the two parent institutions. The President is Mr. R. W. L. Gawn, O.B.E., R.C.N.C., and the hon. secretary, Mr. T. W. Paradise, 1, Paddington-road, Portsmouth.

# THE IRON AND STEEL INSTITUTE.

(*Continued from page* 618.)

CONTINUING our report of the annual general meeting of the Iron and Steel Institute, held at the Institute's offices in London, on April 30 and May 1, we now deal with the afternoon session of Thursday, April 30.

### ROLLING OF BROAD-FLANGE BEAMS.

"Developments in the Rolling of Broad-Flange Beams at the Cargo Fleet Iron Co., Ltd." was the title of the first paper on the agenda. It was by Mr. G. Barry Thomas, general works manager of the company, who described the trials by which broad-flange beams had become a standard product in a conventional two-high cross-country rolling mill originally designed for the production of sections and rails. [In a cross-country rolling mill the stands are arranged laterally instead of in one long line, as in a continuous rolling mill.—ED. E.] The new development, the author stated, would not have been possible without four stands and it would have been difficult to produce the heavier sizes if the floor of the mill had been equipped with skid gear instead of with moving tables. Originally, the mill was of the 32-in. centres type, but, in order to roll 12-in. flanged beams with safety, the roll diameters had been increased to the maximum that the housings would hold, and the distance between the centres of the rolls had been made 35½ in. Forged-steel rolls of 0·45 to 0·50 per cent. carbon and 0·75 to 0·85 per cent. manganese were used. Three ingot sizes were passed through the cogging mill, namely, 25-in. square, weighing 4½ tons; 27-in. square, weighing 5 tons 6 cwt.; and 30-in. square, weighing 6½ tons. The steel rolled was normally of "Lloyd's quality" or of 28-33 tons per square inch tensile strength and containing 0·17 to 0·21 per cent. of carbon and 0·60 to 0·70 per cent. of manganese.

The beams now produced ranged from 6 in. by 6 in. up to 12 in., 14 in., 16 in., 18 in., 20 in., 22 in., and 24 in., all by 12 in. In a few months' time when a fifth stand had been installed it would be possible to increase the range up to 30 in. wide beams, giving beam sizes of either 30 in. by 10½ in., which was the American standard, or 30 in. by 12 in., which was the German standard. In addition to reducing roll changes, it would also enable any British Standard joist from 6 in. to 24 in. by 7½ in. to be rolled as a beam with parallel flanges and, in most cases, with a reduction in weight in lb. per foot. The rolling of beams had in no way affected the normal production of rails, sections, piling and other shapes, as no alterations that would adversely affect the normal level of production had needed to be made. In fact, such alterations as had been made had increased the efficiency of the mill.

### DISCUSSION.

Mr. B. Chetwynd Talbot, who opened the discussion, stated that he had played no part in the practical development of the rolling of broad-flange beams at Cargo Fleet. He had merely had to be convinced that it was a practical proposition, and he had agreed to the expenditure, which was very limited, for the provision of rolling. The company looked on it in the spirit of pioneering a new product in this country, and they realised that by developing the broad-flange beam they were giving to this country advantages which had hitherto been available only in the United States, in particular, and on the Continent. They accepted the fact that their present method was not perfect and could be improved, and no doubt in the course of time it would be. Mr. R. Mather, who spoke next, welcomed, on behalf of the many members of the heavy steel industry, the appearance of a paper of very direct interest to the operating men in that important section of the industry.

Mr. J. McLaughlan said that the author had spoken of a yield of 90 per cent. from bloom to finish. What was it from ingot to finish, as an easier guide? Was there a very long crop end? Was any lubrication used, or was reliance placed on the ordinary method of stripper guards? Had the use of roller straightening machines been considered? Did the author know whether these broad-flange beams were straightened on roller straightening machines elsewhere? It was apparently the intention to produce 30 in. by 12 in. beams and that was really courageous. The next speaker, Mr. E. L. Burgess, asked the author whether any trouble was experienced with the buckling of the webs, either in the intermediate passes or in the finished bar? They, at the Appleby-Frodingham Steelworks, always found some tendency for this in sections of this kind. The author stated that, usually, each motor drove two pairs of rolls, and, apparently, this was the case with the 24-in. beams. Would not the output be improved if the roughing end motor drove only No. 1 stand, which had nine passes, and the finishing end motor drove the other stands, which involved five passes? This would provide a more balanced arrangement.

Mr. G. Barry Thomas, in reply, said, with regard to the yield, that about 90 per cent. of the ingot was brought into the finishing mill. The saleable yield on the smaller sizes was about 80 to 82 per cent., and on the larger sizes, up to 24 in., from 77 to 78 per cent. It was not necessary to take any longer crop than on an ordinary joist. The flanges retained their length up to a foot or two of the end of the bar, so that there was no excessive crop. That also answered the question regarding whether the flanges tended to run off on the front or back end of the bar. They did not; they retained their width up to the crop. For the stripping of the stock from the roll no lubricant was used except an abundance of water, and no trouble in stripping was now experienced. Some difficulties had occurred at the commencement until the flange delivery guides had been made to take the work. Flange guides had been forged in their own blacksmith's shop from 0·35 per cent. carbon steel. The quality of the finished beam was very good. Mr. Burgess had asked whether buckled webs were produced. The answer was no, no more than, and, in fact, slightly less than, normally occurred in the production of a joist. It was possible to have buckled webs through the finishing pass if the roller started with his first position too high and his finishing position too low, but normally there was very little buckling.

### CONTROL PROBLEMS IN COLD STRIP ROLLING.

The next four contributions were taken together for discussion; they were all papers of the Rolling Committee of the Mechanical Working Division of the British Iron and Steel Research Association, and were presented by Mr. R. B. Sims. The first paper, entitled "Speed-Dependent Variables in Cold Strip Rolling," was by Mr. R. B. Sims and Mr. D. F. Arthur, who stated that they had considered the various ways in which the rolling-mill speed could influence the specific roll load and the strip thickness in cold rolling. Experiments to determine the speed-dependent variables had been carried out on the B.I.S.R.A. 10 in. by 10 in. two-high cold strip mill, which was equipped with full Ward-Leonard speed control and had a maximum speed of 307 ft. per minute when the mill motor was lightly loaded. Stable mill speeds as low as 10 ft. per minute could be obtained when the controls were carefully adjusted. In the experimental work both steel and copper strip had been used with thicknesses, on entry, of between 0·050 in. and 0·010 in. The results had shown that the variation of the coefficient of friction between the rolls and the strip was the principal cause of load and thickness changes, and a relationship between the mean coefficient of friction and the speed of the mill had been derived from the experimental results.

The second paper was by Mr. R. B. Sims and dealt with "Performance of Hydrodynamically-Lubricated Roll-Neck Bearings." The author stated that he had conducted an experiment for measuring the mean thickness of the oil film in the bearings of a rolling mill during periods of acceleration and deceleration. The results included measurements made on the B.I.S.R.A. two-high experimental rolling mill and on a large four-high cold strip mill. It had been ascertained that the change in film thickness with speed depended to some extent on the rolling load, and a hysteresis effect had been found to occur when the mill was accelerated from cold.

The third paper: "Control of Strip Thickness in Cold Rolling by Varying the Applied Tensions," was by Mr. R. B. Sims, Mr. J. A. Place and Mr. P. R. A. Briggs, who said that when a rolling mill was run at constant speed, errors in gauge arose from changes in the hardness, width and thickness of the incoming material and from variations in the rolling friction. The gauge of the strip might also vary when the mill speed was changed. The 10 in. by 10 in. experimental rolling mill at the University of Sheffield had been used for the experiments and the performance of prototype closed-loop controllers built on to it had demonstrated that the gauge of rolled strip could be controlled by varying the applied strip tension by an amount depending on an error signal derived from the mill load. Several coils of steel and non-ferrous metals had been rolled consistently to thickness tolerances closer than any previously attained, with apparatus that was suitable for production mills. Two commonly occurring errors in gauge—due to roll eccentricity and to thermal distortions in the mill—were not corrected by this type of gauge controller. The variations in thickness of the rolled strip from these causes were not large, however, and were well within the accepted tolerances for cold-rolled strip; in any case, these variations appeared in all strip rolled at present.

The fourth, and last, paper on control in cold-strip rolling mills was by Mr. R. B. Sims, Mr. J. A. Place and Mr. P. R. A. Briggs, and dealt with "Works Trial of the 'T' Method of Automatic Gauge Control." These authors stated that in a paper presented before the Institution of Mechanical Engineers in 1952, on the origin of the thickness variations in rolled strip, Mr. W. C. F. Hessenberg and Mr. R. B. Sims had suggested two methods for the control of gauge in which the error signal was derived from the mill load. In one of these methods, applicable only to cold-strip mills, correction was obtained by varying the tensions applied to the strip. This system, which was termed the "T" method, had been the subject of laboratory investigations, on a pilot-plant scale, using the B.I.S.R.A. 10 in. by 10 in. experimental cold-rolling mill. Although these experiments had shown clearly that the "T" method of control could produce strip of a high accuracy in gauge, it had been questioned whether the control would function satisfactorily at high rolling speeds and produce strip of good shape. To resolve these doubts, a set of experiments had been carried out on the four-stand, four-high, tandem cold mill at the Shotton works of Messrs. John Summers and Sons, Limited. These experiments had shown that the "T" method of gauge control and automatic tension control had worked satisfactorily on a production mill at high speeds without instability developing and without producing strip of poor shape. Strip had been rolled consistently to far closer tolerances than was possible at present in industry.

### DISCUSSION.

Mr. R. Cook, who opened the discussion, said that if the ultimate answer to the problem of obtaining correct gauge could be found in automatic control, then it was something which should be followed to its ultimate conclusion. He spoke solely from the point of view of a tin-plate manufacturer who utilised a five-stand tandem mill. In the method outlined by the authors, the experiments gave an accuracy of approximately ± 0·0015 in., which might well be suitable for sheet tolerances but which would be unsuitable for tin-plate manufacture; hence, until tin-plate rollers were given evidence of the ability of the control methods described to maintain gauge to a finer tolerance, in the region of ± 0·0004 in., they would not be convinced that the application of the control would be beneficial to them. Coming next to rolling lubrication, under normal rolling conditions the rolling lubricant would be expected to remain constant, but, at times, palm-oil failures occurred, and the tension between the stands where the palm oil was applied was therefore increased. This was dealt with in the normal way, by the operation of the rolling-mill screws, but it was difficult to see how automatic control would behave under these

conditions; rather would it seem that by its operation the strip would be submitted to excessive tension and would break.

The next factor was hardness. It was not clear from the authors' experiments how they would deal with steel of varying hardness, which brought about conditions requiring the initial easing of the screws on No. 1 mill in order not to work-harden the strip before reduction in the following mills. It was difficult to understand how the ultimate shape and gauge could be obtained merely by the control suggested, but, if the authors could find an answer to these difficulties, technicians engaged in rolling would be greatly indebted to them.

Mr. M. F. Dowding stated that these papers represented yet another instalment in a serial story of rolling theory, and gauge control in particular, and if a criticism could be levelled at "the producer of the drama, it would be on the ground that his prologue had been unduly long and that the audience were now getting restive and wanted to see how the play would develop." As a result of negotiations between his firm, Davy and United Engineering Company, Limited, and B.I.S.R.A., the cloak of the producer had fallen very largely on the shoulders of that company. There were many difficulties in transferring the development of automatic gauge control, from a scientific laboratory to an industrial firm, but many of the problems would be simplified by the fact that Mr. Sims had joined them as manager of research from the beginning of the present year.

It might be of some interest to the industry to know the programme on which they intended to proceed. They were starting with the development, to the manufacturing stage, of load meters and other instruments such as tension meters, including the gaugemeter which Mr. Sims had touched upon.* Once these were established as useful, sturdy and practical mill instruments, automatic gauge control in its various forms (on which research and laboratory trials would proceed simultaneously) would be ready for general application. It was hoped that the manufacture of the instruments themselves would be in progress in the early part of 1954, and the gaugemeter at about the same time. Automatic gauge control, in whichever form proved, after experiment, to be the most applicable to the various applications in which firms were interested, would commence about six months later.

Mr. W. Spence said that the tension method of gauge control, although it had been demonstrated successfully on a 1,500-ft. per minute tandem mill rolling sheet gauges, was by no means free from disadvantages. The disadvantage of variable sensitivity with speed on the trial installation described by the authors was, of course, readily overcome on mills fitted with armature-circuit boosters or individual generators. Two main factors, however, seemed to put the tension method at a disadvantage if its universal application were being considered. First, on a modern high-speed mill rolling thin-gauge material the potential change of gauge due to the speed effect could be as high as 30 to 40 per cent., most of which developed in the later stands. To counteract such an increase of gauge by increasing the tension between, say, the last two stands, would call for an additional tension of the same order as the normal running inter-stand tension. Since the latter was usually quite close to the yield-point stress of the material, it followed that the strip would break in the attempt to hold the gauge by tension. The second point was that, since the speed effect was most evident in the later stands, gauge control by tension should properly follow the final stand. High tensions were undesirable between the mill and the wind-up reel in the interests of a good coil, so that if gauge control by tension were to be used after the last stand, it would appear necessary to interpose a pair of puller rolls between the last stand and the reel, together with a drive motor of no small rating. What was really required was automatic gauge control by roll pressure on the hot mill, a problem on which the authors were also working. If the incoming band at the cold mill were of correct gauge from start to finish, the remaining need for automatic control of gauge of cold-rolled strip with varying speed could be adequately met by existing control methods applied to the stand drives.

Mr. K. H. Slack said that the "T" or tension method of gauge control, as pointed out in these papers, could be applied to only a few existing single-stand mills, since quite large tensions were required to cause an appreciable change in strip thickness. There were not many mills equipped with coils capable of applying high tension without damage or possessing the motor powers required for this duty. The control in the "S" or setting method consisted simply of three indicating dials. The method did not rely on a contact micrometer. If the rolled strip did not correspond in thickness to the required value, the rolls were repositioned automatically by a servo. Production was greatly speeded up and the mill operation simplified. The other advantage of the setting method over the tension method was that it gave full gauge control from 3 to 6 in. from the beginning to 1 in. from the end of the coil, whereas, in the tension method, a length of strip of at least the distance between the rolls and the tensioning device was off gauge, and, in addition, there was the off-gauge strip produced before the contact micrometer indicated the correct gauge on the first coil of the batch.

Mr. R. B. Sims, replying to the discussion, said, in answer to Mr. Cook, that it was quite impossible to roll tin-plate at low speeds in a tandem mill. A considerable speed, something of the order of 700 ft. per minute, was required before the gauge was reached in rolling tin-plate. The best that could be done at present with automatic gauge control, therefore, was to provide control for the first three stands in a five-stand tandem mill, by using the "S" method of gauge control, so that what could pass as perfect gauge, $\pm$ 0·0005 or 0·0004 in., in the first three stands, might be produced. Mr. Cook contended that gauge control took away the ability of the operator to vary his screw setting. It did nothing of the kind. On such mills as tandem mills it was almost certain that the control would be by means of the "S" method, namely, the repositioning of the rolls themselves. If a roller wanted to alter his rolls or settings he did so by altering his gauge, and the gauge to which he had altered his mill would be set and fixed until he cared to alter it again.

Mr. J. A. Place, who also replied, said that Mr. Cook had referred to the effect of change in hardness, and questioned whether the gauge controller could, in fact, control this. Hardness was indeed controlled. The gauge controller, in regulating the speed effect, introduced changes in hardness in the strip. The second pass rolled the strip continuously to gauge, and these effects on the first pass were controlled in the second pass by the controller. That disposed of hardness changes in the strip. Mr. Cook had also raised the question of lubrication changes, which were now dealt with by the screws. The controller, he thought, would increase the tension until it broke the strip. The position, however, would be the reverse of that. If the coefficient of friction changed, the roll load would change and the controller would decrease the tension at this point and keep it down until the strip came back to gauge. Mr. Slack was in a strong position to criticise their work, because they agreed that the roll-setting method had many advantages over the "T" method.

The President then adjourned the meeting until 10 a.m. on the following day, Friday, May 1.

*(To be continued.)*

* See also ENGINEERING, page 33, *ante*.

FORMATION OF BRITISH OCCUPATIONAL HYGIENE SOCIETY.—An organisation designed to bring together engineers, chemists, physicists, medical men, and others concerned with problems of maintaining healthy working conditions in offices, factories and workshops, was inaugurated at the London School of Hygiene and Tropical Medicine on April 27, and named the British Occupational Hygiene Society. Dr. Thomas Bedford, director of the Environmental Hygiene Research Unit of the Medical Research Council, was appointed President of the Society. Further information may be obtained from Dr. Bedford, London School of Hygiene and Tropical Medicine, Keppel-street, Gower-street, London, W.C.1, or from the Society's honorary secretary, Mr. P. C. G. Isaac, King's College, Newcastle-upon-Tyne.

# PRESIDENTIAL ADDRESS TO THE INSTITUTION OF METALLURGISTS.*

By DR. L. B. PFEIL, O.B.E., F.R.S.

I AM going to try to interest you by reviewing some of the metallurgical developments that have appealed to me as outstanding during the 30 years that I may claim to have fulfilled the Institution's requirements as a metallurgist. As a student I recall being taught that "Metallurgy is the art of extracting metals from their ores at a profit." This was not then far from the truth; in the early part of this century metallurgy, beyond the field of extraction, consisted largely of the isolated study of the behaviour and uses of individual metals and alloys. How different to-day, when the investigation of general principles controlling the behaviour of metallic materials is the basis of metallurgical science. Fundamentally this change in orientation may be said to be due to the advent of, and accent on "physical metallurgy," with all the implications of that term in its widest sense.

The constitutional study of alloy systems has now come to be the recognised method of initiating the development of materials having specific properties, and it is to the comparatively recent improvement of radiographic and micrographic methods, magnetic, electrical, and other physical tests, and even the development of radioactive tracer technique, that we owe the value of this approach. We are passing from the sale of tons to the sale of properties, and, more generally, to the sale of complex combinations of properties—lightness with strength, hardness with ductility, and so on. The use of physical methods has made an important contribution to the investigation of age-hardening, a phenomenon which, although well established by the researches of Wilm, Merica, and Rosenhain and his colleagues, as occurring in aluminium-base materials, was still, in the 1920s, somewhat of a metallurgical curiosity. The past 30 years have seen the fundamental researches carried out by Gayler, Guinier, Preston, Fink and Smith, and others, and have also witnessed the application of precipitation hardening to copper and copper alloys, austenitic nickel-chromium steels, and high-temperature alloys. The mechanism of the process, the influence of critical states of dispersion, and the inter-relation of precipitation characteristics with other physical properties have thus become sufficiently well understood to make precipitation hardening a regular tool for use in producing materials to specification requirements.

Advances in the knowledge of precipitation hardening have been paralleled in the ferrous field by expanded knowledge of the decomposition of austenite, the mechanism of martensitic hardening and other transformational phenomena in steel. The early years of the century had seen much interest taken in this subject, but, from the speculations which had then been made, we have travelled a long way. By dint of dilatometric, metallographic, magnetic and other methods of study there has now been acquired a fund of basic information which is being utilised in the heat-treatment of steel. In 1929 Bain and his colleagues embarked on a series of investigations on the isothermal decomposition of austenite, the results of which were destined to have far-reaching effects in all countries. As a result of their early work, the now-familiar "S" curve was produced. Later work by these investigators, and by others in all the principal countries of the world, has gone far towards explaining the characteristics and mechanism of transformations in steel.

Turning now to metallurgical products of which the usefulness has been enhanced by new methods of extraction and refining, modifications in composition, and improved processing procedure, copper comes immediately to mind. Voce has recently called attention to the surprising fact that a very large proportion of the knowledge which has had so important an effect on the expanded use of this

* Presented at the annual general meeting of the Institution held in London on Wednesday, May 13, 1953. Abridged.

very old metal has been developed during the past two or three decades. Apart from the old-established brasses, bronzes and gunmetals, the 80:20 and 70:30 cupro-nickels and the nickel silvers, almost the whole of the extensive series of copper-base alloys now at the service of industry has been born within the past 20-30 years. To mention only two or three typical cases: special grades of high-conductivity alloys, such as cadmium-copper, silver-copper and tellurium-copper, now offer a range of materials combining the electrical conductivity required for specific purposes with other characteristics such as higher tensile strength, raised softening temperature, or improved machining qualities, all of which were unattainable in earlier grades of high-conductivity copper-base alloys. Again, in the 1920s, the aluminium and nickel-aluminium bronzes were only beginning to claim some recognition in engineering circles. To-day, such alloys are in use for marine propellers weighing up to 20 tons, and for many other parts in which a combination of strength and corrosion-resistance is required.

One of the most spectacular developments in copper alloys during this period has been in condenser tubing. The stage of development reached to-day makes the "condenseritis" of Admiralty brass tubing during the war of 1914-18 sound almost unreal. The introduction of cupro-nickel and aluminium-brass condenser tubing represents a major contribution of metallurgy to marine engineering.

Aluminium could almost be classed as the "wonder-child" of the period under review. In the early days of the industry there was little demand for the pure metal, and the combinations of properties which could be obtained by alloying it with various other elements were then unrealised, but after the discovery of the age-hardening capacity of aluminium-base materials, intensive research and development revealed their useful qualities, and consumption rose, at first gradually, and then during the period 1930 onwards, to a spectacular extent, in step with the growing importance of the aircraft and automobile industries. The high mechanical strength which can be developed in the light alloys has led to an unprecedented variety of applications in aircraft, automobile, railway, structural, mining and marine engineering. The rise in production which has taken place during recent years may be appreciated from the fact that statistics at present available indicate that, in 1952, the production of aluminium in the "free world" exceeded the combined volume of the older non-ferrous metals—copper, lead and zinc. In the electrical industries also, aluminium has important and developing applications, owing to its high electrical conductivity; an example which is very obvious in this country is the thousands of miles of steel-cored aluminium overhead conductors embodied in the grid system. A recent application is for the sheathing of electric cable, which promises to effect economies in electrical transmission and distribution. The principle of "cladding" has been applied with peculiar success in aluminium products.

Nickel-containing alloys also claim a place in the category of materials known in the 1920s, but developed, modified and extended in use during the past 30 years. Nickel-copper alloys of the Monel and cupro-nickel types, nickel-chromium alloys for electrical resistors, and nickel-silver, broadly represented the range of nickel-containing alloys which could be said to be of commercial interest in the early 1920s. The unusual physical properties of the nickel-iron series had already been investigated, but the practical application of these properties was not yet widely established on a commercial scale. From this broad background there have been developed, as the result of much detailed research, materials having highly specialised properties, varying over a wide range. In the nickel-rich alloy field the application of precipitation hardening has played a not inconsiderable part, as, for example, in K-Monel and S-Monel, which are hardened with aluminium and silicon respectively. More recently, precipitation hardening has been applied effectively to nickel-chromium scale-resistant alloys to develop high creep resistance. This conversion, from the familiar resistance wire in the electric fire to the Nimonic combustion chamber, sheet metal, and blades used in the gas turbine, results from the addition of titanium and aluminium in quantities up to 3 per cent. to the 80-20 nickel-chromium base, the resultant stiffening being attributable to the precipitation of a titanium-rich phase.

The nickel-iron alloys have grown rapidly in industrial importance within the past 30 years. To-day their application is widespread, in many types of temperature-control device and other forms of precision mechanism. The nickel-iron group has also come into prominence in connection with its unusual magnetic properties. With nickel in the range 35 to 80 per cent., magnetic permeability becomes very high and alloys in this range are now important in the electrical-engineering industry, for the loading of cable and for relays, amplifiers and other components used in telecommunication equipment; also for such apparatus as measuring instrument transformers and magnetic shields, in which magnetic "softness" is a primary requirement.

During the past 30 years, cast iron has been developed and improved to an extent which makes the modern engineering irons scarcely recognisable as being related to the earlier types. Nor should the "special" grades of cast iron be omitted, since these materials (such as the austenitic corrosion-resisting and non-magnetic types) have been developed mainly within the past 30 years, and their advent has widened the scope of application of cast irons far beyond limits foreseeable in earlier years. Finally, an important development in this field has been that of the "spheroidal"—or "nodular"—graphite cast irons, in which, by treatment with magnesium or cerium, the flake-graphite structure which is characteristically associated with brittleness in cast iron is changed to a spheroidal form accompanied by toughness and ductility never before attainable in cast irons.

Some mention must be made of the stainless steels which, although firmly established by the early 1920s, have been the subject of much study in later years, with a resultant increased demand. Recent developments in chemical engineering and in the oil industry are creating an ever-growing demand, but it is also interesting to note the potential value of the stainless steels in structural engineering, and in other applications in which there is a call for good mechanical properties combined with corrosion-resistance. The development of precipitation-hardened grades of stainless steel, containing copper, aluminium, titanium, etc., has still further widened their sphere of usefulness. One may hazard the guess that future decades will witness the increased use of the austenitic steels in fields outside that of chemical engineering.

## HAWARDEN BRIDGE STEELWORKS.

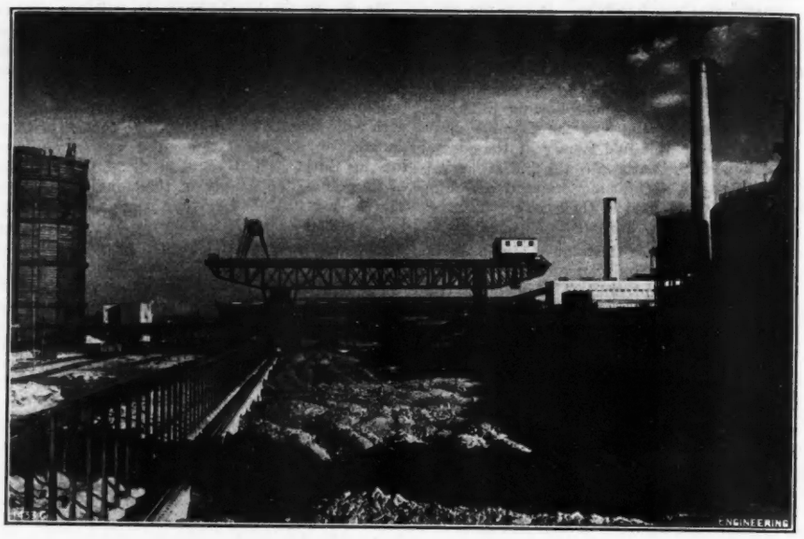


FIG. 1. ORE-STOCKING GROUND.

## BLAST-FURNACE PLANT AT HAWARDEN BRIDGE STEELWORKS.

A MAJOR part of the extensions to the Hawarden Bridge steelworks of Messrs. John Summers and Sons, Limited, is the blast furnace (the largest outside the United States) and ancillary plant. The furnace has an output of 1,000 tons a day and when fully charged holds a burden of about 8,000 tons. The ore stockyard which serves it, shown in Fig. 1, above, is over 1,000 ft. in length and will store more than 200,000 tons of ore. A part-sectional drawing of this notable furnace is given in Fig. 2, on page 656, and, on the same page, Fig. 3 is a general view of the plant. In Fig. 2 the main units, from left to right, are the primary dust-catcher, the blast furnace, hoist house, skip bridge, stock-house, and ore bridge (only partly shown). Messrs. Head, Wrightson and Company, Limited, Thornaby-on-Tees, in association with Messrs. Arthur G. McKee and Company, Cleveland, Ohio, U.S.A., were engaged to assist Messrs. John Summers and Sons in the layout, design and construction of the blast-furnace plant complete with ancillaries, materials-handling, preparation and gas-cleaning plants.

The design of the plant has been based on the requirement of an iron-making capacity of 7,100 tons per week, or approximately 1,000 tons a day. Using ore with an average iron content of 50 per cent., 2,000 tons of ore have to be prepared and handled, in addition to the coke, limestone and sinter required. The plant has been designed as a two-furnace installation, and the second furnace is now under construction. The first blast-furnace, now in operation, will produce its rated capacity when using a burder consisting of 75 per cent. foreign ore and 25 per cent. domestic ore, but it is hoped that the plant, including the ore-preparation plant, will eventually deal with foreign ores only. In view of the fact that all foreign ores are sea-borne, and to provide an ample margin for various contingencies, the ore-handling plant has been designed to handle 750 tons an hour at 135 lb. per cubic foot.

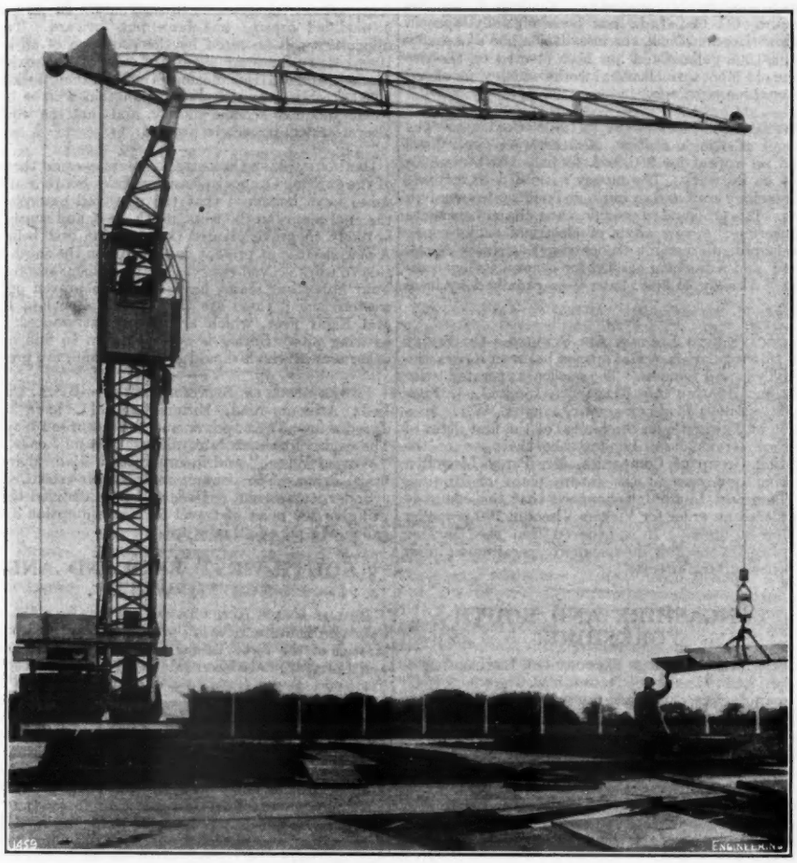
In a subsequent article we shall deal with the design of the blast furnace and associated plant.

*(To be continued.)*

EMPLOYMENT OF W.R.A.C. OFFICERS WITH R.E.M.E.—A scheme has recently been introduced for the employment of qualified women technicians between the ages of 20 and 30 as W.R.A.C. officers for permanent service with R.E.M.E. The qualifications needed are an engineering or science (including physics) degree from a British university, or the equivalent. Particulars of the scheme can be obtained from the Under-Secretary of State, War Office (AG 16(O)), Stanmore, Middlesex.

# TOWER CRANE FOR BUILDING CONSTRUCTION.

THOS. C. WILD (MACHINERY), LTD., SHEFFIELD.



## DIMENSIONALLY-STABLE BASE FOR PHOTOGRAPHIC FILMS.

FILMS have many advantages over glass plates for photographic work on account of their flexibility, lightness and non-fragility. For certain applications, however, notably those involving precise measurements on the photographic image, as in astronomy, aerial surveying, etc., films in general have the disadvantage that the base on which the emulsion is supported tends to swell slightly during the processing operations and to shrink on drying so that the final dimensions of the image are less than before processing; also, a gradual shrinkage occurs over a long period during the subsequent storage of the negatives. Both kinds of shrinkage, moreover, differ in magnitude according to the direction in which it occurs, so that there is a small, but measurable, distortion of the photographic image which, although of no consequence for most purposes, can introduce serious errors in applications of the classes referred to above. To these may be added multi-colour reproduction work, in which it is essential, for first-class results, that all the negatives in a separation set shall be in exact register at every point.

Although the objections mentioned do not apply to glass plates, it is often inconvenient, and sometimes impossible, to use them, and for this reason much research work has been carried out with the object of improving the dimensional stability of films. In this country, the problem has been studied with success at the Bexford film-base plant in Suffolk, jointly owned by Ilford, Limited, and B.X. Plastics, Limited. The plant, the construction of which was only commenced in 1947, is now in full production and is able to supply practically the entire requirements of Ilford, Limited, for normal types of film base and also produces a shrink-resisting base of high stability. This is a notable achievement when it is remembered that the manufacture of film base is an entirely new industry in this country. Until recently, practically all the base required by British photographic manufacturers had to be imported, mainly from the United States, and as the base is the most costly item in the manufacture of films the economic aspects of the new production are of obvious importance. The saving, we understand, exceeds two million dollars per annum.

The new Ilford S.R. base is believed to be one of the most stable plastic bases commercially available and as it is made by a process which leaves the minimum of residual strain in the material the differential dimensional change which occurs in processing or ageing is of a very low order. At present there is no generally accepted British standard or specification for shrink-resisting film base, but the Ilford S.R. base meets the requirements of the U.S. Army-Navy Specification AN-F-40 for topographic film, and for the past six months has been used by the Ilford firm in the production of aerial films as well as for those required in the graphic arts. The standard thickness of the base is 0·005 in., but certain types of graphic-arts films are available with a base thickness of 0·0035 in.

"BRAKE PRESSURE 'WARNING' INDICATOR": ERRATUM.—We regret that, in a paragraph with the above heading which appeared on page 490, *ante*, we incorrectly mentioned "Bosch Limited, Stuttgart, Germany, whose London office is at 45, South Audley-street, London, W.1." Bosch Limited is, in fact, a company registered in the United Kingdom; their capital and control are wholly British, and Bosch Limited is entirely independent of Robert Bosch, G.M.B.H., Stuttgart, Germany, for whose products Bosch Limited are the sole concessionaires in this country.

## TOWER CRANE FOR BUILDING CONSTRUCTION.

THE Wild-Fawcett tower crane, which was shown for the first time at the 1953 British Industries Fair at Castle Bromwich, Birmingham, is the outcome of experience gained in the operation of a similar type of crane which was used experimentally at Norwich in connection with the building of a housing estate, and the number of man-hours per house, to the roofed-in stage, was cut by approximately one half. Attention to the experiment of using a crane of this type for building houses was drawn by Mr. E. Marples, the Parliamentary Secretary to the Ministry of Housing, who expressed the hope that its use would enable houses to be built more rapidly with the labour force available.

The Wild-Fawcett tower crane, as illustrated here, is manufactured in two sizes with maximum reaches of 42 ft. 6 in. and 52 ft., and with lifting capacities at these reaches of 12·5 and 17·0 cwt., respectively, but with the reaches reduced to 13 ft. and 16 ft. 3 in. the two models will lift 35 cwt. to nearly 80 ft. and 40 cwt. to nearly 105 ft., respectively. At the maximum reaches, with the boom in a horizontal position, the heights of lift are approximately 45 ft. and 65 ft.

The general arrangement of both models is identical and they are manufactured by Thomas C. Wild (Machinery), Limited, Sheffield, in conjunction with Messrs. Fawcett, Preston and Company, Limited, Bromborough, Cheshire, the electrical equipment and motors being made by Messrs. Lancashire Dynamo and Crypto, Limited. All motors are of the totally-enclosed crane-rated pattern and each model has separate motors for slewing, travelling and hoisting, the motors being of 2, 4 and 7½ h.p., respectively, for the smaller model and of 4, 7½ and 12½ h.p. for the larger model. All motors are for a 400 to 440-volt three-phase 50-cycle supply, and are controlled from the operator's cabin some 25 ft. above ground level, three different speeds being provided for all motions, which may be made individually or together, as required. The chassis of the crane is of fabricated-steel construction and is mounted on cast-steel wheels to run on 50- to 55-lb. section rails, and the central pivot is of heavy construction with bronze bushes; all gearing is machine cut and the greasing points are extended to facilitate lubrication. An interesting feature is the hydraulic safe-load indicator combining also the functions of a positive overload cut-out, which cuts off current to the motors and applies all brakes, irrespective of the jib position. A number of accessories are available for use with the crane, such as a brick-box of 10 cwt. capacity, and a mortar or concrete skip.

PERFORATED CLAY BRICKS.—The use of perforated clay bricks is limited in the United Kingdom to certain well-defined areas, although their use on the Continent and in the United States is now widespread. The manufacturing advantages to be obtained, and the enhanced physical properties of such bricks, as compared with solid bricks, are fully discussed in Building Research Station Digest, No. 53, *Perforated Clay Bricks*, published by the Stationery Office, Kingsway, London, W.C.2, price 3*d*. net.

RECLASSIFICATION OF NEW DESTROYERS.—Warships of the Daring class, the Admiralty announce, are to be re-classified and will cease to be referred to as destroyers. Their official designation in future will be "Daring class ships," while, on less formal occasions, they may be referred to simply as "Darings." These vessels, which were originally intended for use as large fleet destroyers, have come to be used mainly in a tactical capacity as light cruisers. They are equipped with a variety of modern electronic devices and have shown themselves to be effective units of the Royal Navy, whether employed as light cruisers, destroyers, anti-submarine frigates, or anti-aircraft vessels. They have a displacement of 2,610 tons, an overall length of 390 ft. and a beam of 43 ft. Their armament consists of six 4·5-in. guns, six 40-mm. anti-aircraft guns, ten 21-in. torpedo tubes and a weapon for use against submarines, known as the Squid. The Daring class will consist of eight vessels, of which six have already been completed.

# NOTES FROM THE INDUSTRIAL CENTRES.

## SCOTLAND.

GLASGOW WATER-SUPPLY DEVELOPMENTS.—A water supply scheme to meet the needs of housing developments east of Wellhouse, Glasgow, will cost 219,000*l*. It will involve laying a 24-in. rising main from the termination of the east main at Ruchazie reservoir to a new 3,000,000-gallon surface reservoir to be constructed at Garthamlock and the erection of pumping station and a 1,000,000-gallon water tower adjacent to the new reservoir.

DEVELOPMENT PLAN AND INDUSTRIES OF GREENOCK.—A part of Greenock's development plan which, if approved, would encroach on the shipbuilding and marine-engineering industry in the town, was criticised on May 11 by Mr. George Morrison, managing director of the Greenock Dockyard Co., Ltd., in his presidential address at the annual meeting of the Greenock Chamber of Commerce. He added that Greenock had not solved its problem in the search for alternative industries which might offset any slump in the heavy trades.

MACHINE-TOOL FACTORY AT THORNLIEBANK.—The building, by Scottish Industrial Estates, Ltd., of a new factory at Thornliebank, Glasgow, for Vertimax Ltd., machine-tool makers, is expected to begin in September. The firm of Vertimax, which was formed last year is a subsidiary of Andersons (Newton Mearns), Ltd., motor engineers. One of the principals, Mr. James Anderson, has designed a new type of hydraulically-operated lathe, an example of which has been sent for exhibition at the Toronto Fair, to take place next month.

AIRCRAFT CARRIER TO BE BROKEN UP.—H.M.S. Formidable, the 23,000-ton aircraft carrier, arrived at Ward's shipbreaking yard, Inverkeithing, on May 12, to be broken up. She was towed from Portsmouth by three tugs.

THE LATE MR. R. S. HUIE.—The death occurred on May 7 of Mr. Robert Smith Huie, Campbeltown, a director of the century-old firm of John Huie & Co., Ltd., motor engineers, which was founded by his grandfather. He was 61.

ELECTRICITY SUPPLY IN THE SHETLANDS.—A factory on the island of Bressay in the Shetlands is now being supplied with electric power from the Diesel generating station at Lerwick through an 11-kV submarine cable. This cable, which is about 500 yards long, was manufactured by British Insulated Callender's Cables, Ltd.

## CLEVELAND AND THE NORTHERN COUNTIES.

DRIFT COAL MINES TO BE OPENED IN DURHAM.—The Durham Coal Board have announced that four new drift mines are to be started in the No. 4 Area (South-West Durham). These include two at Westerton, one at Thinford and one at Evenwood. At Westerton an old mine has been reopened and when the two drifts are in operation, the output will reach 600 tons a day, it is anticipated, for from 15 to 20 years. The pits will be fully mechanised. The Thinford drift will produce 2,000 tons weekly for 20 years, while that at Evenwood will have a weekly output of 1,200 tons and about 120 miners will be engaged.

STEELWORKS DEVELOPMENT AT W. HARTLEPOOL.—Details have been given of a development and expansion scheme now being carried out at the West Hartlepool works of the South Durham Iron and Steel Co., Ltd. By the middle of this year it is hoped to have in production a 250-ton steel open-hearth furnace, while improvements and enlargements are proposed to other steel furnaces which will bring ingot capacity to 500,000 tons per annum. This is twice the pre-war figure. The second stage of the work includes an ore-handling plant, the construction of coke-ovens and the building of a 20-ft. hearth diameter blast furnace which will be in production in 2½ years' time. These and other developments are intended to bring the output of steel plates up to 350,000 tons annually.

THE FATE OF GREATHAM AIRPORT.—A committee of investigation appointed recently by a conference of Teesside local authorities, have recommended that all the local authorities should share the cost of running Greatham airport, owned by the West Hartlepool Corporation. West Hartlepool announced recently that the airport is to be closed as it is operating at a loss. It has been suggested that as it is used by the whole of the Teesside area the loss should not be borne by West Hartlepool alone. It has been estimated that, on present running costs, a loss of 5,000*l*. can be expected annually. This loss could be met by about a dozen local councils.

SUNDERLAND OIL-STORAGE INSTALLATION.—An oil-storage installation erected at Sunderland by the Vacuum Oil Co., Ltd., has been officially opened. Built at Hendon Dock, the installation has a capacity of 1,000,000 gallons and has been erected on the site of the old Monsanto chemical works which were closed two or three years ago.

APPEAL FOR FUNDS BY KING'S COLLEGE.—The Council of King's College, Newcastle-on-Tyne, have made an appeal for 250,000*l*. to help the College to carry on its work. The money is needed to increase the teaching staff and to improve facilities for research work. It is proposed to provide a new chair of chemical engineering; a new chair of electrical engineering; a post-graduate research studentship; scientific equipment; and a working capital for general College purposes. Already 41,500*l*. have been promised by local firms.

NEWCASTLE TO LONDON AIR SERVICE.—On Friday May 15, a regular air service opened between Newcastle-upon-Tyne and London. The service is operated twice daily by Hunting Air Transport Limited, 5, Fitzhardinge-street, Portman-square, London, W.1. In a speech at Newcastle on the arrival of the first flight of the new service from London, the chairman of the Hunting Group of Companies, Mr. Percy Llewellyn Hunting, referring to the future plans of Hunting Air Transport Limited, announced that the company had placed an order for Vickers Viscount 700 propeller turbine air liners. It is believed that the Hunting company are the first independent operators to order propeller turbine aircraft.

## LANCASHIRE AND SOUTH YORKSHIRE.

CATHODE-RAY TUBES FACTORY FOR LANCASHIRE.—Mullard Ltd., have decided to establish a new factory for the manufacture of cathode-ray tubes. At present, the manufacture of these tubes is mainly concentrated in the company's factory at Mitcham, near London, but following discussions with the Board of Trade, it has been decided to transfer the manufacture to a new factory to be built under the facilities provided by the Distribution of Industry Act in the North-West Lancashire development area. The factory will be within easy reach of the company's existing factory at Blackburn.

THE EMPLOYMENT POSITION.—In Sheffield, the number of unemployed and persons on short-time is down to 2,685, the lowest total for this year. The improvement is due to some recovery in the cutlery and silverware trades and in small-tool manufacture. The biggest improvement is among women workers. Only one in every hundred registered persons in Sheffield is out of employment. Lack of orders from the motor-car and other industries, however, is officially given as the explanation of the necessity to reduce temporarily, to four days a week, the employment of nearly half of the 1,150 workmen at the Rotherham works of J. J. Habershon & Sons, Ltd.

WORK FOR "TEENAGERS."—In two years, the Sheffield Youth Employment Bureau officials have conducted 25,000 interviews with school leavers. Ninety per cent. of the "teenagers" who have obtained work through the Bureau's advice are keeping in touch by means of visits or by writing letters, compared with 50 per cent. which is the normal figure for the country as a whole. The numbers who are dissatisfied with the jobs they have taken and want to change subsequently is very small. The Youth Employment Officer, Mr. G. W. Brand, states that talks and letters help to iron out maladjustments.

LOSS OF COAL OUTPUT.—The Yorkshire Miners' President, Mr. J. R. A. Machen, states that more coal has been lost recently in Yorkshire disputes than for a long time past, and this he attributes to the "cluttering up" of the conciliation machinery. He adds that already 44 cases have been referred to the disputes committee, or about eleven times as many as were submitted in the East Midlands in the whole of last year. He urges that there should be more settlements at the pits.

IRISH CUTS IN AGRICULTURAL-TOOL IMPORTS.—One of Sheffield's best markets for agricultural tools was Eire until a 25 per cent. tariff on the import of scythes, sickles, billhooks, slashers, and hay and root-crop knives, was restored recently. Cancellations of existing orders are being received in Sheffield, the tool makers stating that the duty is designed to protect the Irish tool industry.

## THE MIDLANDS.

BANBURY RAILWAY STATION.—A scheme, drawn up in 1946 for the rebuilding of Banbury railway station, which was to have been a joint arrangement accommodating the three Regions serving the town, has been scrapped on the grounds of economy. In its place, a modified scheme has been put forward. Traffic difficulties will be eased by the provision of an additional down line on the west side of the existing station, and all the platforms will be lengthened to 1,000 ft. It is expected that sanction will be given to the modified scheme shortly, and that the work of alteration will be able to proceed.

CANNOCK CHASE COALFIELD.—Boreholes on the edge of the existing Cannock Chase coalfield, South Staffordshire, have indicated that the expected extension of the coal seams to the west, north-west, and south-east is likely to prove greater than was at first believed. A new shaft is at present being sunk on the south-east side to work proved reserves of about 200,000,000 tons. Four important seams have now been proved on the western side; these are the Brooch, Benches, Park, and Eight Feet, which are at present worked from existing pits. Boring is now going on to find out if other seams, which should be below them, are present.

POWER-ASSISTED BICYCLE ENGINE.—B.S.A. Cycles, Ltd., Armoury-road, Birmingham, 11, have introduced a new 35 c.c. power unit for motorised bicycles. The engine forms an integral part of a unit called the "Winged Wheel," and incorporates a 9½ in. diameter brake drum. The power unit is an air-cooled, single cylinder, two-stroke engine, and it is claimed that it will give 200 miles of travel for a consumption of one gallon of a petrol-oil mixture.

## SOUTH-WEST ENGLAND AND SOUTH WALES.

BRIDGE ACROSS RIVER TAMAR.—Plans for a 485,000*l*. Callender-Hamilton road bridge across a 1,800-ft. stretch of the river Tamar at Saltash, to link Devon and Cornwall, have been submitted to the Ministry of Transport as a prelude to a new approach by a delegation drawn from Devon and Cornwall County Councils, Plymouth City Council and Tamarside local authorities. Last year, the Minister of Transport was asked to sanction a high-level project estimated, with road works, to cost 6,000,000*l*., but after receiving a deputation he announced that this could be regarded as "only a very long-term project" because of the country's economic position. The new low-level plan, prepared with professional advice, is estimated to cost only one-twelfth of the high-level project. Tentatively, the scheme allows for a rolling or telescopic centre span of 200 ft. for the passage of large ships, and a clear height of 30 ft. above high water spring tide—46 ft. at low water—for the passage of small harbour craft. The type of bridge selected allows two-way traffic on a 20-ft. wide carriageway, and with headroom of 17 ft. 6 in. will allow for the crossing of double-decked omnibuses. It is a bridge of the Warren girder type, with variable section trusses, constructed in multiples of 10 ft. in length from a set of standard parts.

CLOSING OF MORE TIN-PLATE WORKS.—During the past week the Briton Ferry Steel Co., Ltd., have announced the closing down of two tin-plate works—the Gwalia Works at Briton Ferry and the Morriston and Midland Works at Morriston. About 720 employees mostly men, will be affected by the closing of the two works. It is stated by the management that the order books for hot-rolled tin-plates are such that the mills at the two works would not be able to operate after May 16 and that, after stocks in hand had been processed, the works would be placed on a care and maintenance basis. This means that all six tin-plate works operated by the company have been closed since the beginning of the year.

CONSENT TO POWER STATION REFUSED.—The Minister of Fuel and Power has refused his consent to the building of a new power station at Machen, Monmouthshire. The reasons are not officially stated, but the decision is said to have been reached as the result of evidence given at a recent public inquiry. The British Electricity Authority inform us that they are taking expeditious steps to develop an alternative scheme.

S.W. DIVISION OF NATIONAL COAL BOARD.—The annual report of the South-Western Division of the National Coal Board shows that the pits were operated at a loss of 3,044,690*l*. last year, which was equivalent to 2*s*. 5½*d*. per ton on the 24,879,829 tons raised. But the Division was the only one in the country to improve its financial position, in comparison with the previous year, when the loss was 3,534,963*l*., or 2*s*. 11*d*. per ton. It cost 3*l*. 9*s*. 7½*d*. to produce a ton of coal compared with 3*l*. 0*s*. 6½*d*. in 1951, and each ton sold brought in an average price of 3*l*. 7*s*. 2*d*. against 2*l*. 17*s*. 9*d*. in the preceding year.

## NOTICES OF MEETINGS.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Monday morning in the week preceding the date of the meeting.

SOCIETY OF INSTRUMENT TECHNOLOGY.—Tuesday, May 26, Manson House, 26, Portland-place, W.1. 6 p.m., Annual General Meeting. 7 p.m., "The Instrumentation of Pilot and Experimental Scale Plant," by Mr. W. A. Goldstein.

ROYAL STATISTICAL SOCIETY.—Wednesday, May 27, 5.15 p.m., London School of Hygiene and Tropical Medicine, Keppel-street, Gower-street, W.C.1. "An Experimental Study of Quota Sampling," by Mr. C. A. Moser and Mr. A. Stuart.

ROYAL MICROSCOPICAL SOCIETY.—Wednesday, May 27, 5.30 p.m., Tavistock House South, Tavistock-square, W.C.1. (i) "High-Speed Automatic Counting of Microscopic Particles—The Flying-Spot Microscope," by Mr. D. Causley; and (ii) Demonstration of the Permanent-Magnet Electron Microscope, by Mr. R. W. Horne.

INSTITUTE OF BRITISH FOUNDRYMEN.—*Birmingham Branch:* Wednesday, May 27, 7.15 p.m., James Watt Memorial Institute, Great Charles-street, Birmingham. "Some Practical Aspects of Aluminium Founding," by Mr. E. Raybould.

INSTITUTION OF MINING AND METALLURGY.—Thursday, May 28, Geological Society's Apartments, Burlington House, Piccadilly, W.1. 4 p.m., Annual General Meeting (open to corporate and non-corporate members only). 5.15 p.m., Presidential Address, by Professor J. A. S. Ritson.

INSTITUTION OF CIVIL ENGINEERS.—*Hydraulics Engineering Division:* Thursday, May 28, 5.30 p.m., Great George-street, Westminster, S.W.1. "The Lynmouth Flood of August, 1952," by Mr. C. H. Dobbie and Mr. P. O. Wolf.

INCORPORATED PLANT ENGINEERS.—*South Yorkshire Branch:* Thursday, May 28, 7.30 p.m., Grand Hotel, Sheffield. Discussion on "New Developments in the Coal-Mining Industry." *Birmingham Branch:* Friday, May 29, 7.30 p.m., Imperial Hotel, Birmingham. "Dust Control," by Mr. R. J. Pitt. *London Branch:* Tuesday, June 9, 7 p.m., Royal Society of Arts, John Adam-street, Adelphi, W.C.2. "Thermal Insulation of Plant and Buildings," by Mr. C. G. Bower. *Manchester Branch:* Tuesday, June 9, 7.15 p.m., Engineers' Club, Albert-square, Manchester. "Combustion Heat and Power," by Mr. C. F. Roberts. *Newcastle-on-Tyne Branch:* Thursday, June 11, 7.30 p.m., Roadway House, Oxford-street, Newcastle-upon-Tyne. "The Plant Engineer and the Factories Act," by Mr. A. Hewitt.

CHEMICAL SOCIETY.—Thursday, June 4, 7.30 p.m., Chemical Society's Apartments, Burlington House, Piccadilly, W.1. Meeting to commemorate the present-day aspects of the work of Sir William Ramsay. (i) "The Work of Sir William Ramsay in Relation to Nuclear Science and Technology," by Mr. J. S. Anderson; (ii) "Recent Results of Researches on the Composition of the Stratosphere," by Mr. F. A. Paneth; (iii) "Modern Light Sources," by Mr. H. G. Jenkins; (iv) "Industrial Applications of the Rare Gases in Metallurgy," by Mr. L. C. Bannister; and (v) "The Use of Helium in Diving," by Mr. H. J. Taylor.

ROYAL INSTITUTION.—Friday, June 5, 9 p.m., 21, Albemarle-street, W.1. "Glaciers," by Dr. M. F. Perutz.

STOKE-ON-TRENT ASSOCIATION OF ENGINEERS.—Saturday, June 6, 7 p.m., George Hotel, Stoke-on-Trent. Annual General Meeting.

THIRD CONFERENCE OF NOBEL PRIZE WINNERS.—A conference of Nobel prize winners in physics will be held, under the auspices of Count Lennart Bernadotte, at the theatre, Lindau, Lake Constance, Bavaria, Germany, from Monday, June 29, to Thursday, July 2. Special efforts are being made to interest practical men whose daily work is based on the results of the investigations of these scientists. Physicists from the United Kingdom will be particularly welcome at the conference. Papers to be read will include "Discovery of the Natural Transmutation of the Radio-Elements," by Professor Frederick Soddy, F.R.S.; "High-Altitude Flights with Free Balloons," by Professor C. F. Powell, F.R.S.; "Progress and Difficulties in the Quantum Theory of Elementary Particles," by Professor Werner Heisenberg; "Röntgen-Ray Interferences," by Professor Max von Laue; "Quantum Mechanics and the Ether," by Professor P. A. M. Dirac; and "Biochemical Effect of Ionising Radiation," by Professor Georg von Hevesy. Various social functions and visits to places of interest are being arranged, including an excursion to Count Bernadotte's botanical gardens on the Isle of Mainau. Further information may be obtained from Dr. F. K. Hein, Fischer-gasse 37, Lindau, Bodensee, Germany. Professor Soddy, 39, Overhill-drive, Brighton 6, will reply to inquiries addressed to him before May 25.

## LAUNCHES AND TRIAL TRIPS.

M.S. "BALTISTAN."—Single-screw cargo liner, with accommodation for five passengers, built by John Readhead & Sons, Ltd., South Shields, for the Strick Line, Ltd. (Managers: Frank C. Strick & Co., Ltd.), London, E.C.3. Main dimensions: 450 ft. between perpendiculars by 58 ft. 6 in. by 32 ft. 2 in. to upper deck; deadweight capacity, 9,750 tons on a draught of 25 ft. 8 in. N.E.M.-Doxford four-cylinder opposed-piston oil engine, developing 4,400 b.h.p. at 115 r.p.m. in service, constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Wallsend-on-Tyne. Speed, about 13 knots. Launch, April 14.

S.S. "BRITISH SAILOR."—Single-screw oil tanker, built and engined by John Brown & Co., Ltd., Clydebank, for the British Tanker Co., Ltd., London, E.C.2. Main dimensions: 665 ft. by 85 ft. 6 in. by 46 ft. 9 in.; deadweight capacity, 32,000 tons on a draught of 35 ft. Double-reduction geared turbines developing 12,500 s.h.p. and a speed of 14½ knots. Trial trip, April 17.

S.S. "CALTEX CANBERRA."—Single-screw oil tanker, built by the Furness Shipbuilding Co. Ltd., Haverton Hill, County Durham, for the Overseas Tankship (U.K.), Ltd., London, W.1. First vessel of two. Main dimensions: 544 ft. 4 in. overall by 70 ft. by 39 ft. 9 in. to upper deck; deadweight capacity, 17,400 tons on a summer draught of 30 ft. 4½ in.; oil-tank capacity, 16,140 tons. Steam turbines with double-reduction gearing, developing 7,300 s.h.p. at 100 r.p.m., constructed by Richardsons, Westgarth & Co., Ltd., Wallsend-on-Tyne; and two Foster Wheeler oil-burning boilers. Speed, 15 knots. Trial trip, April 27 and 28.

S.S. "APPLEDORE."—Single-screw cargo vessel, built and engined by William Gray & Co., Ltd., West Hartlepool, for the Maritime Shipping and Trading Co., Ltd. (Managers: Michalinos & Co., Ltd.), London, E.C.2. Main dimensions: 431 ft. between perpendiculars by 57 ft. 6 in. by 38 ft. 3 in. to shelter deck; deadweight capacity, about 10,100 tons on a draught of 26 ft. 6 in.; gross tonnage, 5,842. Triple-expansion steam engine, working in conjunction with a Bauer-Wach exhaust turbine; and three oil-fired boilers. Service speed, 11½ knots. Trial trip, April 30.

M.S. "AVONFIELD."—Single-screw oil tanker, built and engined by William Doxford & Sons, Ltd., Sunderland, for Hunting & Son, Ltd., Newcastle-upon-Tyne. First vessel of an order for two. Main dimensions: 505 ft. by 69 ft. 9 in. by 39 ft.; deadweight capacity, 16,800 tons on a draught of 30 ft. Doxford five-cylinder opposed-piston oil engine, developing approximately 6,450 b.h.p. at 117 r.p.m. Speed on trial, 14½ knots. Trial trip, May 8.

M.S. "BRITTA."—Single-screw oil tanker, built and engined by Harland and Wolff, Ltd., Govan, Glasgow, for Mr. A. H. Mathieson, Oslo, Norway. Main dimensions: 540 ft. between perpendiculars by 73 ft. by 39 ft. 3 in.; deadweight capacity, about 18,500 tons. Harland-B. and W. six-cylinder two-stroke single-acting opposed-piston oil engine. Launch, May 12.

M.S. "BLANDFORD."—Single-screw oil tanker, built and engined by Harland and Wolff, Ltd., Govan, Glasgow, for Blandford Shipping Co., Ltd., London. Main dimensions; 531 ft. between perpendiculars by 74 ft. by 38 ft. 3 in.; deadweight capacity, about 18,500 tons. Harland-B. and W. seven-cylinder single-acting two-stroke heavy-oil engine. Trial trip, May 13 and 14.

S.S. "NORTHERN SCEPTRE."—Single-screw trawler, built by Cochrane & Sons, Ltd., Selby, Yorkshire, for Northern Trawlers, Ltd., Grimsby. Main dimensions: 180 ft. between perpendiculars by 32 ft. by 16 ft. 6 in.; gross tonnage, 750. Triple-expansion steam engine, developing 1,150 i.h.p., and one coal-burning boiler, constructed by Amos and Smith, Ltd., Hull. Launch, May 14.

S.S. "ALIKI LIVANOS."—Single-screw two-deck cargo vessel, built and engined by William Gray & Co., Ltd., West Hartlepool, for Mr. N. G. Livanos, Piræus, Greece. Main dimensions: 431 ft. between perpendiculars by 57 ft. 6 in. by 38 ft. 3 in. to upper deck; deadweight capacity, 11,200 tons on a draught of 28 ft. 6½ in. Vessel constructed so as to carry 10,000 tons deadweight on a draught of 26 ft. 7 in. when operating with open shelter deck. Triple-expansion steam engine, working in conjunction with a Bauer-Wach exhaust turbine and three oil-fired boilers. Service speed, 11½ knots. Trial trip, May 14.

M.S. "ALVA CAPE."—Single-screw oil tanker built by the Greenock Dockyard Co., Ltd., Greenock, for the Alva Steamship Co., Ltd., (Managers: Navigation and Coal Trade Co., Ltd.), London, E.C.3. Main dimensions: 545 ft. 3 in. overall by 69 ft. by 38 ft. 6 in. to upper deck; deadweight capacity, 16,500 tons on a mean draught of 29 ft. 10 in.; oil-carrying capacity, about 786,650 cub. ft.; approximate gross tonnage, 11,200. Scott-Doxford six-cylinder opposed-piston oil engine, developing 6,600 b.h.p. at 115 r.p.m. in service, constructed by Scotts' Shipbuilding and Engineering Co., Ltd., Greenock. Machinery installed by John G. Kincaid & Co., Ltd., Greenock. Speed, 15 knots. Launch, May 15.

## PERSONAL.

MR. JOHN ELLIOT, chairman of the Railway Executive, has been elected President of the Institute of Transport, 80, Portland-place, London, W.1, and will assume office on October 1, on the retirement of MR. C. T. BRUNNER.

LT.-COL. T. EUSTACE SMITH has been elected chairman of the Tyne Shipbuilders' Association, in succession to MR. G. H. R. TOWERS.

MR. W. R. STEVENS, B.Sc., M.I.E.E., has been elected President of the Illuminating Engineering Society for 1953-54.

MR. CLEMENT STEPHENSON, M.Inst.N.A., shipyard general manager of William Doxford and Sons, Ltd., Sunderland, has been elected a director of the company.

DR. G. S. HISLOP, B.Sc., A.R.T.C., M.I.Mech.E., A.F.R.Ae.S., has been appointed chief designer in the helicopter division of the Fairey Aviation Co. Ltd., Hayes, Middlesex.

MR. N. G. CADMAN, M.I.Mech.E., M.I.Loco.E., deputy works manager, Westinghouse Brake and Signal Co., Ltd., 82, York-way, London, N.1, has been appointed works manager as from May 1.

MR. WALTER NEWMAN, chief designer of Salford Electrical Instruments, Ltd., has retired after 45 years of service with the company.

MR. W. GRIFFITH EDWARDS has retired from the board of Hordern, Mason and Edwards, Ltd., Woodlands Farm-road, Tyburn, Birmingham, having served as a director since the company's incorporation in 1923.

MR. MICHAEL CLEAR, B.Sc., M.I.Mech.E., who joined the Brush ABOE Group of Companies in 1945 and, for the past three years, has been managing director of Brush ABOE (Southern Africa) Ltd., has now been appointed group sales director of the Brush Group of Companies and a member of the board of Associated British Oil Engines Ltd.

MR. JEFFREY QUILL, O.B.E., A.F.C., has been appointed sales and liaison manager for the Supermarine Works of Vickers-Armstrongs Ltd., Vickers House, Broadway, London, S.W.1.

MR. G. F. YORKE has retired from the position of joint managing director of the Midland Motor Cylinder Co. Ltd., after nearly 35 years of service with the firm. MR. F. A. W. LIVERMORE has been appointed works director.

MR. J. C. ROBERTSON has been appointed honorary treasurer of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow, C.2, in place of MR. G. J. INNES, who has resigned.

MR. G. W. PERKS, of Stockton-on-Tees, has been elected chairman of the North of England section of the Institution of Gas Engineers.

MR. A. PROCTOR, manager, engineering division, George Angus & Co. Ltd., Newcastle-upon-Tyne, and MR. D. E. F. CANNEY, development manager, have been elected to the board of directors.

MR. K. J. CLARKE, A.M.I.E.E., who has been on the staff of the Birmingham district office of the British Thomson-Houston Co., Ltd., Rugby, for the past 16 years, has now taken up a staff appointment at the firm's Sheffield district office. MR. J. GOLDSMITH has left the firm's London district office to join the staff of the Birmingham office.

MR. HARRY HOGG, assistant rolling-mill manager, Cargo Fleet Iron Co. Ltd., Middlesbrough, has retired after 43 years of service with the firm.

MR. C. J. PORTEOUS has been appointed London sales manager for Brown, Lenox & Co., Ltd., Pontypridd and Millwall, E.14. He is in charge of the company's new sales office at 157, Victoria-street, S.W.1. (Telephone: TATe gallery 9191.)

B.E.N. PATENTS LTD., High Wycombe, Buckinghamshire, have appointed MR. W. LUDLOW TAYLOR to be their sales supervisor for the United Kingdom. Their new sales and service representative for Scotland is MR. R. W. DEANE; for Cambridgeshire, Essex, Hertfordshire, Norfolk and Suffolk, MR. J. B. HERBERT; for Cornwall, Devon, Gloucester, Monmouth and Somerset, MR. J. A. H. BAILY; for Derbyshire, Hereford, Shropshire, Staffordshire, Worcester and Warwickshire, MR. B. R. GARRATT; and for Berkshire, Wiltshire, Buckinghamshire and Oxfordshire, MR. D. F. TAYLOR.

MR. ERIC COLEBY, legal adviser to the Railway Executive, in the legal service of the British Transport Commission, 55, Broadway, London, S.W.1, retired on May 9 on attaining the age limit.

GILLOTTS LTD., Albert Terrace-road, Sheffield, have been acquired by RUBERY, OWEN & CO., LTD., Darlaston, South Staffordshire. The Sheffield firm is the 35th member of the OWEN ORGANISATION.

RICHARD THOMAS AND BALDWINS LTD., and THE STEEL COMPANY OF WALES LTD., have opened a sales office for tin-plate and other sheet goods at White House, 111, New-street, Birmingham, 2.

LEYLAND MOTORS LTD., Leyland, Lancashire, have appointed CHARLES KELLER, Theaterstrasse 10, Zürich, to be their agent in Switzerland.

# BLAST FURNACE AT HAWARDEN BRIDGE STEELWORKS

HEAD, WRIGHTSON & CO., LTD., THORNABY-ON-TEES.

(*For Description, see Page* 652.)

*Fig. 2.*

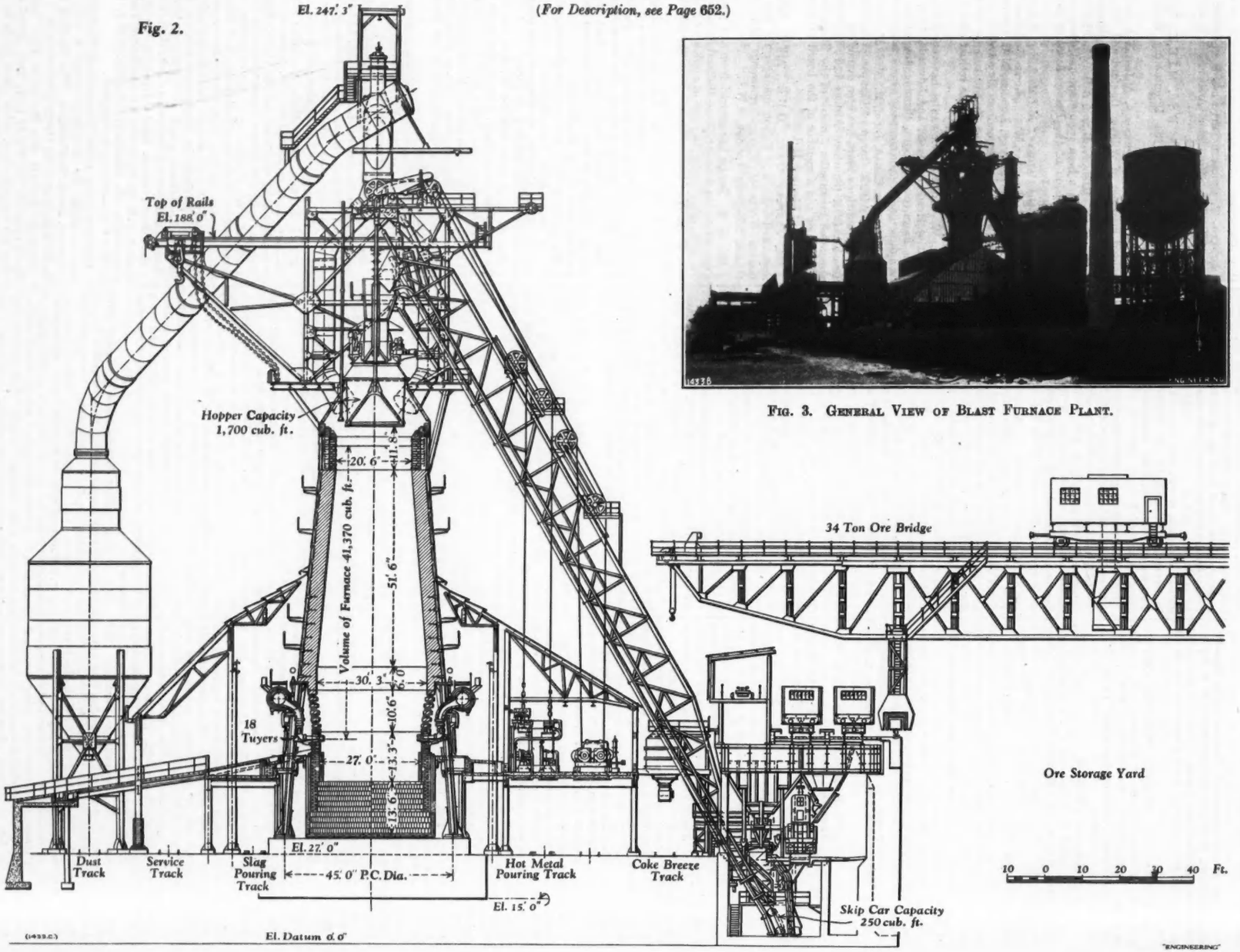





FIG. 3. GENERAL VIEW OF BLAST FURNACE PLANT.

# ENGINEERING

35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.2.

*Registered at the General Post Office as a Newspaper.*

We desire to call the attention of our readers to the fact that the above is the address of our Registered Offices, and that no connection exists between this Journal and any other publication bearing a similar title.

*Telegraphic Address:*

ENGINEERING, LESQUARE, LONDON.

*Telephone Numbers:*

TEMPLE BAR 3663 and 3664.

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## SUBSCRIPTIONS.

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| | |
|---|---|
| For the United Kingdom and all places abroad, with the exception of Canada | £5 10 0 |
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## ADVERTISEMENT RATES.

Terms for displayed advertisements can be obtained on application to the Manager. The pages are 12 in. deep and 9 in. wide, divisible into four columns 2¼ in. wide. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

The charge for advertisements classified under the headings of "Appointments Open," "Situations Wanted," "Tenders," etc., is 10*s.* for the first four lines or under, and 2*s.* 6*d.* per line up to one inch. The line averages six words and when an advertisement measures an inch or more, the charge is 30*s.* per inch. If use is made of a box number the extra charge is 1*s.* per insertion, with the exception of advertisements appearing under "Situations Wanted." Series discounts for all classified advertisements can be obtained at the following rates:—5 per cent. for six; 12½ per cent. for thirteen; 25 per cent. for twenty-six; and 33⅓ per cent. for fifty-two insertions.

## TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be received not later than first post Monday.

"Copy" instructions and alterations to standing advertisements for display announcements must be received 16 days previous to the date of publication, otherwise it may be impossible to submit proofs for approval.

The Proprietors will not hold themselves responsible for advertisers' blocks left in their possession for more than two years.


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# ENGINEERING

*FRIDAY, MAY 22, 1953.*

VOL. 175. No. 4556.


## A POOR RETURN.

THE National Coal Board's results* for last year's working show that the schemes of reconstruction and technical development to which this nationalised industry is being treated are more than nullified by the failure to secure a fair measure of work from the miners. Whether that is the fault of the miners themselves, of the managers, of the Coal Board, or simply of the character of the organisation, is less easy to decide. It is well to remember, however, that the rank-and-file employees of any industry, in their readiness to work and co-operate, are conditioned by their environment, and the environment is determined mainly by the character of the organisation and the leaders who people it. The history of the industry may be a potent factor, but no one can alter it; only the future can be moulded, by present thought and action.

If everyone responsible for the coal industry's future—officers of the Coal Board and Divisions, planners, engineers and designers—cannot succeed in carrying the men in the pits with them in the next few years, then it will be time to ask whether they have failed in their duty (which is unlikely) or whether they have been committed to a system which is ill-suited to the needs of the industry. The sum of 45·5*l.* million spent on capital account in 1952, even though it was less than the total authorised, cannot immediately bear fruit, but at least the country is entitled to some assurance that, in due time, it can be regarded as money well spent. The 1952 figures for coal produced, absenteeism, output per man, and so forth, give little promise of such an assurance.

The mines produced 214·3 million tons of coal in 1952, nearly 2½ million tons more than in 1951, but the increase was mainly in the early part of the year. Each man worked, on the average, the same number of shifts (250) as in 1951, but produced less coal per shift. The output per man-year in 1952 was 299 tons, 4 tons less than in 1951. Until last year, the productivity had risen about 3 per cent. every year since nationalisation, but in 1952 it fell by more than 1 per cent. Productivity is expressed in terms of man-shifts per 1,000 tons, so that an increase in this figure denotes a fall in productivity. The worst increase was that of 5 per cent. in the Scottish Division, and the only decrease, of 0·2 per cent., occurred in the East Midlands Division. The outlook, however, is not as bleak as these figures by themselves suggest. Thus, productivity declined most in those Divisions which had to train the most new recruits. About 3,000 more men received coal-face training than in 1951, and unfortunately, but necessarily, about 2,000 more of the most skilled and experienced men were employed on development and special work. The total manpower in the industry showed an increase greater than in any year since 1947, when there were still many miners returning from service with the Armed Forces; the total of 720,500 at the end of 1952 was 22,500 more than that at the beginning. The Coal Board deserve praise for having overcome this problem of recruitment, which a few years ago seemed to be almost intractable, but it now seems that they are faced with the more insistent problem of obtaining the greater quantity of coal which alone will justify the increased manpower.

What is being done to this end? Leaving aside questions of pay and bonus, productivity and absenteeism, the extensive schemes of reconstruction and development merit the admiration of the technically minded. The Board's plan for capital investment, described in the 1950 annual report, envisaged the expenditure of 520,000,000*l.* on the collieries, and, in addition, about 115,000,000*l.* on coke ovens, on services to the collieries, such as power stations and central workshops, and on work such as research, borings, etc. It was hoped that 138,000,000*l.* (allowing for rises in prices since 1949) would be invested in the collieries in 1950, 1951 and 1952. In the event, the actual expenditure was only 89,000,000*l.*, or less than two-thirds of what was planned. This lag in expenditure is regarded by the Board as a matter of serious concern, especially as it is now believed that the original total was an under-estimation.

The failure to invest at the planned rate is held to be due to the fact that the planning staffs have been too heavily burdened. The detailed preparation of reconstruction schemes, the placing of contracts, and the control of progress require highly trained planning staffs, and there have been too few men in the industry with experience of large-scale reconstruction. The Reid Committee, in 1945, pointed out that, "unfortunately, there is a serious dearth of mining engineers who possess the knowledge and experience necessary to undertake the far-reaching schemes which are essential." As coal becomes progressively more difficult to win, mining engineers will be more and more in demand. This is a great opportunity for young engineers, which is not likely to diminish in years to come.

Though most of the coal produced is now cut mechanically, the work of loading on to conveyors and tubs is almost everywhere done by hand. In 1952, 11·1 million tons of coal were power-loaded (compared with 8·7 million tons in 1951), Meco-Moore machines being responsible for the greater part of this work. The number in use increased during the year from 81 to 112, and the difficulty of turning them round at the end of each run along the coal face was overcome experimentally in some Divisions by using a double-ended machine which can cut and load in both directions of travel, or by detaching the cutter unit from the machine at the end of the run and fitting a spare unit for the return run. More coal ploughs were used in 1952

* *National Coal Board Report and Accounts for* 1952. H.M. Stationery Office. [Price 8*s.* 6*d.* net.]

than in the previous year, but they have been designed and developed for use in soft coal, of which there is little in Britain. Experiments have shown, however, that under suitable conditions they can be used in moderately hard seams if the coal is either undercut in front of them or softened by water-infusion. Seven Samson strippers, which employ a hydraulically-operated wedge to dislodge the coal from the face, produced 458,000 tons of coal during the year, and experience was gained of the conditions under which they can be used.

All these machines are used in long-wall mining. The room-and-pillar system of working, to which Joy continuous mining machines can be applied with great advantage, is becoming rare in this country. By the end of the year, the three Joy machines in use had produced 62,000 tons of coal, at an average output per man-shift at the coal face of 30·7 tons, which is just about ten times the national average output per man-shift—3·15 tons. Other mining techniques in which progress was made in 1952 included the prop-free front system of roof support; the use of "yielding" props with hydraulic or friction mechanisms; roof-bolting, in which the roof is held by steel plates or bars bolted into it; the application of air-conditioning to give comfortable working conditions in mines which are so deep that the ventilating air has to be cooled; and the profitable use of methane as town gas or for firing colliery boilers.

The pace of the Coal Board's engineering development generally is to be accelerated by setting up an engineering establishment, which will supplement the efforts of those manufacturers who, in the past, have provided most of the industry's new developments. The establishment is to "develop inventions which otherwise might never be brought into production," and also meet the industry's need for improved facilities for inspecting and testing new equipment and materials and for devising standard testing procedures for local use. Meanwhile, underground transport, which is thought to offer greater scope for improvement in efficiency than other mining operation, is being studied with care. Modern belt conveyors, and locomotives drawing large mine cars, are replacing rope haulage as far as possible. There are some pits where it is more economical, or even necessary, to use conveyors, and in these cases there may be scope for installing some new types in which the belt itself is made of steel or is suspended from steel wire ropes which take the drive. Attempts are being made also to develop cheaper methods of froth flotation, and a start has been made on the application of "work study" methods to improve the layout of collieries, in the deployment of labour and equipment and in the organisation of the flow of work. Science is being harnessed to the needs of the industry in two main spheres: in research, and in and sampling, analysis, etc. The research establishment set up several years ago at Stoke Orchard, near Cheltenham, is to concentrate on studies of the treatment and processing of coal when a new station at Isleworth, Middlesex, has taken over the work on underground mining problems and on mechanical and electrical engineering.

In technical developments the annual report stresses future projects more than actual achievements of the year under review. For an industry which has been nationalised more than six years this is disappointing. By this time there should be more positive results. The country is entitled to know why productivity has gone down when so much is being spent on capital investment. The Minister of Fuel and Power has rejected a proposal for an inquiry, but Parliament should at least be told whether there is any chance that the labour situation in the mines will cease to thwart the objects of the invested capital—capital which could be employed profitably by almost any other industry in the country.

## INDIAN TRANSPORT.

On July 18 next, it will be six years since the passing of the India Independence Act. The period has not been long for the reorganisation of a country with an area of more than a million sq. miles, and a population of some 400 million. The early years were disturbed by disputes with Pakistan, the working out of agreements with the Princely States, and by the unsettled condition of world affairs in general. The last of these items is still operative, but by 1950 the Government had sufficient control of the whole complicated situation to appoint a Planning Commission to draw up one of the Five Year Plans now so popular with governments in difficulty. The particular virtue of five years as a planning period seems to have been first realised by Russia, and her example has been widely followed.

The organisation, or reorganisation, or control of a country of the size of India, with a highly varied population, speaking eight main languages and dozens of secondary ones, with widespread illiteracy and a low average standard of living, is a task which will not be completed in five years and which would require many articles for its survey. There is one aspect of it, however, which is a vital element in the building up of the state of material prosperity which is the hall-mark of modern civilisation; this is transport. An example of the difficulties with which India was faced when her present constitution came into existence is, in this connection, furnished by the fact that the creation of Pakistan as a separate country resulted in the severing of the railway connection between Assam and the rest of India. The main Indian railways have now been amalgamated to form a common system which operates under the direction of the Central Government, but that would not seem to forbid the working out of an arrangement by which Indian traffic should work over lines which now lie in a foreign country. However, the matter has been dealt with by constructing a new connecting line, in Indian territory, passing round the north of East Pakistan.

The Indian railways have for very many years been a valuable customer for British locomotive builders. The connection is not yet broken, but, like many other countries, India is making efforts to render herself self-contained. The soundness of this policy for a country of which the main exports are raw materials is questionable, but, none the less, it is stated by Mr. Rowland Owen, United Kingdom Senior Trade Commissioner in India, that "India's policy in regard to the supply of locomotives is self-sufficiency after 1955." Two locomotive building works have been established, one Government-owned and the other operated by the Tata Engineering and Locomotive Company, the Government holding one-third of the shares. Technical assistance is provided for the Government factory by the Locomotive Manufacturers Association of Great Britain; 16 locomotives were built in 1951, and an output of 120 is planned for 1955. The Tata factory receives technical assistance from a German firm; it is designed for an ultimate output of 50 locomotives per year.

Information on this matter is provided by Mr. Owen in a recent Overseas Economic Survey.* He does not report the establishment of any new factory for the building of railway wagons, and states that existing capacity fully occupied on new building and repair will leave some 3,000 wagons per year to be obtained from outside sources. For passenger coaches, however, a new Government factory is being built under Swiss supervision. It will have a capacity of 350 all-metal coaches per year; some 200 per year will have to be obtained from outside sources. No doubt, there will be opportunities for British firms to supply plant and equipment in connection with these various developments. This possibly also applies in connection with railway extensions and upkeep. During 1950-51, 66 miles of new line were opened, 250 miles are now under construction, and surveys are completed for a further 200 miles.

The railways of India were largely built up by British initiative and enterprise. The same thing does not apply to the roads, which, under modern conditions, have become as important an element in a transport system as the railways. The roads of India, if they are to be brought up to a standard remotely approaching that of developed industrial countries, should provide a market for road-construction plant on a very large scale. India, with an area of much more than a million sq. miles, has only 255,460 miles of roads, while the United Kingdom, with an area of 94,000 sq. miles, has 184,000 miles. The state of the Indian roads is, in general, poor, and only about one-third of the existing mileage is suitable for motor traffic. The Five Year Plan provided for the construction of 750 miles of national highways, but it is pointed out in the report that of the 17,000,000*l.* provided for the work, only 750,000*l.* represented the purchase of machinery from abroad. Most of the money will be spent on labour, local material and the acquisition of land. In spite of this, however, there should be a useful market for road construction and maintenance plant.

The Indian market for road vehicles is, at present, largely supplied from assembly plants established by British and American manufacturers. The bodies of commercial vehicles are almost all being built in India. Of 1,595 commercial vehicles imported from Great Britain in 1951-52, only 29 were complete with bodies; the rest were imported as chassis. It is estimated that the capacity of the assembly plants is 71,700 vehicles annually, which, Mr. Owen states, is far in excess of Indian demand. The actual production has never reached one-third of the possible. The manufacture of components and parts is extending and the import of some examples of these is forbidden. As in the railway field, there is a desire for self-sufficiency and the policy of the Government is to encourage local manufacture. The report states that "the Planning Commission clearly contemplates the disappearance of most of the present assemblies." It has set a target of 25,000 vehicles per year to be produced in India by 1955-56. As the local market is relatively small, it is doubtful if an artificially fostered industry could operate on an economic basis; nevertheless, this policy of restriction is likely to increase the difficulties of British manufacturers.

Shipping, the other main branch of transport, is likewise being subjected to the same policy of self-sufficiency, and it has been announced that "at the earliest practicable date" the whole of the Indian coastal trade shall be in Indian hands. Shipbuilding, however, is another matter, and British firms are not at present faced with the protected competition experienced by locomotive and motor-vehicle builders. The shipyard at Vizagapatam is the only one in India capable of dealing with ocean-going vessels. The first ship was launched from this yard in March, 1948, but the cost of construction of that, and some eight which followed, was "quite uneconomical." Representations were made to the Government, which placed an order for three ships and subsidised them "to the extent of the difference between the actual cost and the cost of a similar vessel constructed in the United Kingdom." The subsidy on each ship was 150,000*l.*, but even so there was not only no profit, but no interest on the capital invested. The yard was in 1952 taken over by a new company, of which the Government holds two-thirds of the shares.

* *India: Economic and Commercial Conditions.* H.M. Stationery Office. [Price 11s. net.]

# NOTES.

## LAUNCH OF THE LINERS "ORSOVA" AND "ARCADIA."

ON May 14, two new passenger vessels, for service between England and Australia, were launched. The Orsova, when complete, will go in operation with the Orient Steam Navigation Company, Limited, and the Arcadia with the P. and O. Steam Navigation Company. The Orsova, which was launched by Lady Anderson, has been building in the yards of Messrs. Vickers-Armstrongs Limited, Barrow-in-Furness. She has a gross registered tonnage of 28,200; an overall length of 722 ft. 9 in.; a moulded breadth of 90 ft. 6 in., and a depth moulded, to "E" deck, of 50 ft. The draught is 30 ft. 9 in. and the service speed will be 22½ knots. The vessel is propelled by twin screws driven by a set of geared turbines of the Parsons type "Pametrada" design. The output is 34,000 shaft horse-power, the overload shaft horse-power being 42,500, with propeller revolutions of 130 and 140, respectively. She will carry 685 first-class passengers amidships, and 813 tourist-class passengers aft. The crew of 642 will occupy the forward section of the ship. An unusual feature of the vessel is the fact that she is mastless, and is the first liner of this size to be so arranged. Less noticeable but perhaps more notable is her all-welded hull; again, she is the largest liner in the world with this form of construction. The Arcadia, which was launched by Mrs. D. F. Anderson, wife of the deputy-chairman of the P. and O. on the same day, is a two-masted vessel, and a feature of this boat is the installation of an improved Clydebank type of funnel to improve smoke clearance from the upper decks. She has been built by Messrs. John Brown and Company (Clydebank), Limited, at their Clydebank shipyard, and a sister ship is being built at Messrs. Harland and Wolff's yard, Queen's Island, Belfast. She is also of approximately 28,000 tons; is 718 ft. long, and 90 ft. 6 in. in breadth, with a load draught of 30 ft. 3 in. She will have accommodation for 670 first-class passengers and 735 tourist class. The deadweight cargo capacity will be approximately 6,150 tons. The power will be derived from single-reduction turbines developing 42,500 shaft horse-power, giving a service speed of 22 knots. She is expected to go into service early in 1954. Speaking at the launching, Mr. J. W. Beck, director and secretary of John Brown's, said that competition from Germany and Japan is growing and making itself felt, particularly on trade routes. To meet this competition, he said, it was incumbent upon shipbuilders to maintain promised delivery dates, and to do this there must be a continued and adequate supply of the right kind of steel.

## COLLECTION OF LETTERS TO SIR WILLIAM SIEMENS.

The originals of over 250 letters received by Sir William Siemens (1823-1883) from many scientists, statesmen and noblemen of his period, have been acquired by Sir George Nelson, chairman and managing director of the English Electric Company, Limited, who has had them bound in two handsome volumes which were shown to some guests of the company at the Savoy Hotel, London, on Thursday, May 14. Although Sir William Siemens had many other claims to fame in the world of engineering and science of his time, his name is probably best remembered in association with the regenerative furnace which was, and still is, employed extensively in steel melting, glass making and other industrial processes. Some particulars of his life and work will be found in the obituary notice which was published in ENGINEERING, vol. 36, page 477 (1883). A third volume, containing printed copies of all the letters, and facsimile copies of 22 of them, was prepared for presentation to the Institution of Electrical Engineers, and was handed to the President, Colonel B. H. Leeson, on the same day as the volumes were exhibited at the Savoy Hotel. All three volumes, it need hardly be mentioned, are fine examples of the bookbinder's craft, having been hand-bound in Cape Morocco leather, tanned and dyed in this country from South African skins. The facsimile reproductions in the presentation volume have been printed by the collotype process on paper closely resembling that used for the original letters, and in some cases containing the same water mark; the results are practically indistinguishable from the originals. The typography of the printed letters is also of a very high standard. In addition to the three hand-bound volumes mentioned, 1,000 copies of a general edition of the letters have been prepared for presentation to universities, libraries and engineering societies. Of the letters themselves, it can be said that a few of them are of considerable scientific importance, but they all serve to show his widespread interests and to throw light on the manners of the times in which he lived.

## LUNCHEON OF THE BRITISH ENGINEERS' ASSOCIATION.

The historical background against which the new American Administration is seeking to develop a programme for a higher level of international trade, formed the introductory remarks of the Hon. Lincoln Gordon, Minister of Economic Affairs, at the United States Embassy in London, when he spoke at the annual luncheon of the British Engineers' Association, held in London on Thursday, May 14. Pointing out that, ever since the War of Independence, the majority of immigrants into the United States were people who wished to get away from the Old World, Mr. Gordon declared that for more than 100 years there had existed a period of determined isolationism among American businessmen while the internal economy of the country was being established. To illustrate the shift that is occurring in United States' opinion, Mr. Gordon quoted at some length from President Eisenhower's State of the Union Message and he continued by drawing attention to three steps that were being taken by the Administration at the present time. The first was the introduction of the Customs Simplification Bill into Congress during this week; secondly, the recommendation of the President, that a commission should be appointed to review American foreign economic policy and to suggest the necessary legislative changes required to promote international trade; and thirdly, the extension that is to be made to the Reciprocal Trade Agreements Act in its present form so that the *status quo* should be maintained during the period of review. Turning from policy, Mr. Gordon substantiated his thesis of a changing opinion by quoting the relevant figures for imports into the United States for the periods just prior to and following the war. He suggested that the case of the contract for equipment for the Chief Joseph Dam was an isolated instance, not in keeping with the overall picture, and he drew attention to the statement of Mr. Charles Wilson, the American Secretary of Defence, to the effect that all the tenders received had been rejected on the grounds of unsatisfactory specifications. Mr. Wilson had continued his statement by affirming his belief in "trade not aid." Mr. Gordon concluded by declaring his opinion that, in a short time, the markets of the United States would be open to the engineering industries of all countries on free and equal terms.

## BRITISH STANDARDS FOR POLYTHENE TUBING.

On Friday, May 15, the British Plastics Federation, 47-48, Piccadilly, London, W.1, held a Press conference to introduce two new British Standard Specifications. One was B.S.S. 1973-1953, for Polythene Tube for General Purposes, and the other was B.S.S. 1972-1953, for Polythene Tube for Cold Water Services. Both standards of these had been prepared under the supervision of the Plastics Industry Standards Committee of the British Standards Institution, and, in accordance with the policy of the Institution, as many sections of industry as possible co-operated, both the user and the manufacturer taking a full part. Speaking at the conference, Mr. C. S. Dingley, Chairman of the Federation, said that Great Britain had always been first in the field with polythene tubing, and he expressed the hope that these standards, which had taken some four years to produce, would assist in the manufacture of tubing of a uniformly acceptable quality. A large quantity of polythene tube has already been used in this country and the information contained in the standard has been based on knowledge gained. Polythene itself was discovered in 1933 by a team of research chemists who were studying the effect of high temperatures on ethylene gas. When first developed, it was used almost entirely for its electrical and insulating properties. Later, the possible range of applications of this new material became apparent and gave rise to the need for some form of manufacturing standard. The Chairman of the Technical Committee which did much of the work in producing these standards was Mr. N. J. Pugh, City Water Engineer of Coventry and past-President of the Institution of Water Engineers. He was one of the first engineers to carry out large scale installations of this material for use in domestic water supplies. The standards deal with the colour of the tube in relation to its application and gives the composition for varying grades. Length is mentioned, and the standard diameters and gauge are given together with the test pressures in a tabulated form. Details of suitable tests are covered and sketches of some test apparatus included. Suitable methods for joining the pipe are also given, and some of these are illustrated. Among the advantages of using polythene tube is the fact that it does not corrode, and is not attacked by acids in drinking water or in the soil. It has been estimated that 5*l*. million which might have been saved, has been spent in this country in one year in replacing corroded cold-water metal piping. Polythene tube can be produced as a continuous extrusion and therefore supplied in lengths as great as 500 ft. if required. In weight it is eight times lighter than the equivalent bore of steel tubing, and up to 11 times lighter than lead tubing; for this reason one man can carry 500 ft. of coiled tubing of ½ in. bore. Its elastic properties mean that it will withstand a freeze-up without bursting. Besides being used for water tubing, it is at present being used for conveying liquid foods, and for surgical purposes.

## THE INSTITUTION OF METALLURGISTS.

The membership of the Institution of Metallurgists continues to grow steadily; on December 31, 1952, the total on the roll was 2,530, compared with 2,316 a year previously. The progress made last year was referred to in the report of Council, covering the calendar year 1952 and presented to the ninth annual general meeting of the Institution, held under the chairmanship of Professor H. O'Neill, the retiring President, at the Park Lane Hotel, Piccadilly, London, on May 13. It was stated that the Institution's examinations had been held in London, Glasgow, Birmingham, Coventry and Bristol and also in Australia, South Africa and India. Early in 1952, an approach had been made by the Institution to the British Association with the proposal that a sub-section be created for metallurgy at the 1953 meeting. As a result, Professor H. O'Neill had been elected a member of the Chemistry Section committee for the 1953 meeting at Liverpool and it was anticipated that several metallurgical papers would be presented at the meeting. Towards the end of 1952, the Council had been approached by the platinum-metals industry to sponsor an exhibition of metals of the platinum group to commemorate the triple jubilee of the discovery of platinum by Wollaston. It was agreed to hold an exhibition at Grosvenor House, London, W.1, in October next. This would probably be open for one week. The report of the honorary treasurer, Mr. G. L. Bailey, showed that the total income of the Institution for the year was 5,438*l*., and the expenditure, 5,003*l*., leaving a credit balance of 435*l*. After the reports of Council and of the treasurer had been adopted, Professor O'Neill announced that Dr. L. B. Pfeil, O.B.E., F.R.S., had been elected President for the ensuing year; that Mr. C. W. Dannatt and Dr. L. Northcott had been elected vice-presidents, and; that Mr. G. L. Bailey, C.B.E., had been re-elected honorary treasurer. The two members of Council elected by the Fellows were Dr. W. O. Alexander and Mr. G. Meikle and the two elected by the associates

were Mr. E. G. Cutbush and Mr. P. E. Kersting. In inducting Dr. Pfeil into the presidential chair, Professor O'Neill drew attention to the new President's outstanding work on the oxidation and scaling of metals and on heat-resisting alloys for high-temperature service. Dr. Pfeil then read his presidential address, which dealt with the metallurgical developments of the past 30 years. We hope to reprint the address in a forthcoming issue.

### THE TIMBER DEVELOPMENT ASSOCIATION, LIMITED.

The Association has recently issued its annual report for 1952. This emphasises the work and objects of the Association, which may be expressed briefly as the education of users and potential users in the uses of timber, its behaviour and artistic merits. The Association sponsored many interesting tests during the year, one of which was the testing to destruction of a timber truss of 57 ft. 4 in. span in the Forest Products Research Laboratory, of the Department of Scientific and Industrial Research, described in the issue of ENGINEERING for January 25, 1952 (vol. 173, page 127). Other tests have been carried out on plywood tubes, the panel heating of wood-block floors, and the tensile strength of plywoods to provide design data for a timber grain silo. Numerous standard designs were also produced; the iroko lamp-standards designed in conjunction with the Sidmouth Urban District Council, are certainly attractive, far more so than many existing lamp-standards fabricated from other materials. The Advisory Design Service of the Association has produced a number of other designs, such as a three-pinned arch frame for a school assembly hall, grain bins for a crop-drying plant. A measure of the activities of the Association is the literature which it has dispensed; no fewer than 237,785 publications, papers and designs were distributed during the year, and of these about 82,000 were sent to students of the connected professions and trades.

### THE BRITISH CAST CONCRETE FEDERATION.

The twenty-fifth anniversary number of the Bulletin of the British Cast Concrete Federation* not only ranges over a number of types of building uses for cast and pre-cast concrete, but also gives some illuminating information on the progress achieved during the past 25 years. Viewing the industry as a whole, the increases both in output and in the range of products manufactured is immediately evident, and during the period covered the output has more than trebled, the industry now employing about 20,000 men. During this period there have been many new applications and in house production, in particular, there has been an increasing use of pre-cast flue blocks, eaves, gutters, and flights of stairs; on the highways, kerbs, lighting and traction standards, 'bus shelters and benches are being produced from pre-cast concrete to an increasing extent; similarly, on the railways, pre-cast sleepers, tunnel segments and framed sheds are in increasing demand. There has been considerable development in glass-concrete construction, and from the every-day pavement lights, application has extended to vertical mullion grid windows and arched roofs. In the cast-stone side of the industry, this material is increasingly replacing carved natural stone at a fraction of the cost, casting being facilitated by the development of vinyl-resin moulds. Many columns, capitals and tracery windows in existence are examples of modern cast-stone technique. The Bulletin deals extensively with residential buildings which make use of pre-cast and pre-fabricated wall slabs, columns, beams and numerous other items employed by the building trade, including roof tiles, the production of which now amounts to nearly 700 million a year, sufficient, it is said, to give shelter to the combined populations of Bradford, Portsmouth and the Isle of Wight.

* Incorporating the British Concrete Federation, the Cast Concrete Products Association, Limited, and the National Association of Cast Concrete Manufacturers. The head offices are at 17, Amhurst Road, Ealing, London, W.13.

## WORK OF ASLIB IN 1952.

INDUSTRIAL and commercial firms in increasing numbers took advantage of the services offered by the Association of Special Libraries and Information Bureaux (Aslib) in 1952. The number of such firms who are members of Aslib increased by 40 per cent., and nearly half the inquiries handled by Aslib's information service and library came from them. Inquiries for information on the location of specific documents, addresses of various organisations, bibliographical details, references on given subjects, and relating to other matters on which information is generally known to exist but cannot be located by the firm with its own resources. The total number of inquiries received, other than those in connection with the documentary reproduction service, rose from 3,521 in 1951 to 7,662 in 1952.

A consultant service to give authoritative advice on the establishment and efficient conduct of special libraries and information departments was started during the year with the aid of a special grant from the Department of Scientific and Industrial Research (the D.S.I.R. pay an annual grant to Aslib based on the membership). A consultant was appointed in January, 1952, and the introduction of the service aroused widespread interest. It soon became apparent, however, that neither members nor non-members were yet ready to pay for the service in sufficient numbers to ensure that it would become self-supporting within the two years laid down in the terms of the special grant. The service has therefore been reorganised this year, the duties being spread over the entire senior staff instead of being carried out by one consultant only.

Certain specialised interests are served by the six groups within Aslib which have been formed in recent years. The development of the Aeronautical Group and of the Engineering Group has been reported in ENGINEERING from time to time; the former has made particularly rapid progress, and the latter, formed more recently, is now passing the preliminary stages and beginning to achieve some results which should be useful to engineering firms generally. There are also groups dealing with fuel and power, textiles, economics, and food and agriculture. In the provinces, Aslib branches continued to serve members well.

On the financial side, the annual report (from which these details are taken) states that for the first time in the Association's history, the Council were able to authorise the investment of funds to start a reserve against future contingencies. The membership at the end of the year was 1,434, compared with 1,219 a year earlier.

RECONSTRUCTION AND RENOVATION OF CHARING CROSS HOTEL.—Charing Cross Hotel, in the Strand, London, W.C.2, which was built in 1865, was badly damaged by enemy action during the Second World War. The two upper floors were practically destroyed and the damage, of course, extended to some of the lower floors. The building was taken over by the Hotels Executive of the British Transport Commission in 1948 and since then the upper floors have been reconstructed, central heating has been installed throughout, additional bathrooms have been provided and the hotel has been completely restored and redecorated. Over 90 new bedrooms have been added, making 250 in all. It has been possible to keep the Hotel open while the work, the cost of which was about 250,000*l.*, was being carried out. The work, it may be mentioned, involved first the removal of nearly 5,000 tons of rubble and scrap material, and the greater part of the works, including the rebuilding of the upper floors, the central-heating installation and the additional bathrooms, has been completed in just over a year. Incidentally, the upper part of the front elevation of the building has been materially improved in appearance. These particulars have been extracted from a statement by Sir Harry Methven, K.B.E., Chairman of the Hotels Executive, at a Press conference held in the Hotel on Friday last, in the course of which he also explained what has been, or is being, done to improve many other hotels owned by the British Transport Commission in London and the provinces. He also referred to the work of modernising station dining and refreshment rooms and to improvements in the provision of meals on trains. In the latter connection, he mentioned that 303 restaurant-car services and 325 buffet-car services would be running on British Railways every week-day during the summer.

## COMPENSATION FOR PERSONAL INJURIES.

By C. F. MAYSON, A.M.I.E.E.

THE award of damages by Courts of Law to persons injured as a result of accident or negligence is always something of a mystery to the layman in legal matters. The amount of such damages can, however, be of direct interest to engineers and others who are concerned with the employment of labour, for they have considerable responsibilities under both the general law of negligence and such statutory enactments as the Factories Act, 1937. Although accidents to workpeople are usually covered by insurance, such cover is not invariably all-embracing and, in consequence, liability may fall directly upon the unfortunate employer. Claims for personal injuries are on the increase (due to causes which have already been discussed in these columns*), and more actions are now brought on this ground than on any other.

In the days when accident cases were almost always tried by a judge and jury, it was the latter's function to assess the damages. At the present time, juries have practically disappeared from the trial of civil cases, and, save on rare occasions, it is now the judge alone who decides how much to award. This is certainly a step in the right direction, for some of the awards made by juries in the past were quite fantastic and out of all proportion to the injuries suffered. There is no doubt that, in many cases, the juries were influenced by factors which had no real bearing; but upon what basis and by what reasoning they arrived at their findings is outside the knowledge of everyone except, perhaps, the juries themselves. The Courts have now laid down principles for judges to follow when carrying out their unenviable duty of so fixing damages as to provide adequate and fair compensation for an injured person, and it is these principles which are considered below.

We are here concerned, not with the causes of injuries which are the subject of compensation, but with the measure of damages that those injuries may be said to warrant. So long as there has been negligence or a breach of a statutory provision by someone who owes a duty of care to the injured person, that person will be able to establish a claim to damages. It matters not whether the relationship between the parties is contractual (e.g., is between employer and employee, or public transport authority and passenger), or otherwise (as where the plumber who comes to mend a burst pipe in a house trips over a loose floor-board and breaks his leg); the basis of the award will be the same.

The general rule is that the injured person is to be put, as nearly as possible, into the position in which he would have been had no injury been done to him. This can only be accomplished by money, even though, in many cases, money provides no real compensation. As Lord Justice Birkett said in a recent case†: "If money is no compensation, then 5,000*l.*, 10,000*l.*, 15,000*l.*, or 20,000*l.* become meaningless, but the Courts have been compelled by the logic of circumstances to decree that in cases of personal injury the only thing open to the Court is to make an award of damages in money."

How, then, is such a payment to be assessed? Many factors have to be taken into consideration, not the least of which is the pain and suffering undergone, and that which may occur, or recur, in the future. Another is that a person with severe injuries may lose many of the amenities of life, and may be dependent upon someone else to help him with such mundane matters as dressing or moving about. Further, his disablement will

* "Safety Provisions of the Factories Acts," ENGINEERING, vol. 174, page 214 (1952).

† Rushton *v.* National Coal Board. (1953) 1 *Weekly Law Reports*, page 292.

almost certainly result in reduced earnings. There are many other matters to be looked at, including loss of expectation of life, but, even when that has been done, the fact remains that damages cannot be standardised, and there is no real yardstick by which they can be measured. To quote Lord Justice Birkett again, this time in another case*: "The assessment of damages in cases of personal injuries is, perhaps, one of the most difficult tasks which a judge has to perform . . . The task is so difficult because the elements which must be considered in forming the assessment in any given case vary so infinitely from other cases that there can be no fixed and unalterable standard for assessing the amounts from those particular elements. Although there is no fixed and unalterable standard, the Courts have been making these assessments over many years, and I think that they do form some guide to the kind of figure which is appropriate to the facts of any particular case, it being for the judge . . . to consider the special facts in each case."

There are two qualifications to the general rule, the first being that it is the injured person's duty to take all reasonable steps to mitigate his injury. For example, if his accident has rendered him unfit to do the type of work he was engaged in before, he is expected, nevertheless, to take what employment he can, though he is not bound, of course, to take work merely because it has been offered to him, however suitable it may be. The second qualification is that, if he has in any way contributed to his injury by his own act, such act must be taken into consideration as reducing the damages which would otherwise have been awarded. This is governed by the Law Reform (Contributory Negligence) Act, 1945, under the provisions of which any negligence on the part of the injured person is assessed as a percentage of the whole cause, and the damages awarded are reduced in that proportion.

A few examples of awards made in recent cases will serve to illustrate the difficulties attendant upon assessment. A colliery worker, aged 36, had his gloved right hand caught in a conveyor belt, and his right arm was literally torn from his body. The injury was such that he could never wear an artificial limb. Some ribs were fractured, also, causing chronic bronchitis. This man had originally intended to become a commercial artist, but had taken work in a mine owing to some domestic trouble. The judge, taking all these circumstances into account, and allowing for the fact that he was in receipt of a small pension, and that he had a certain earning capacity (but not as an artist), awarded him 10,000*l*. This sum was reduced by the Court of Appeal to 7,000*l*.

In another case, a factory worker, aged 61, suffered such severe injuries to his hands that the right hand had to be amputated; the left one was so emaciated that only the thumb was of any use. Damages of 10,000*l*. were awarded, but were reduced on appeal to 7,000*l*. In contrast to these two cases, damages of 10,000*l*., granted to a boy who had lost both hands at work, were confirmed by the Court of Appeal, who took into account the fact that he would not be able, even with artificial hands, to dress or undress himself or do other necessary things without assistance, and that he would never be able to indulge in the usual forms of recreation which appeal to the healthy man. Although the Court of Appeal may, and often does, reduce an excessive award, it is not unknown for a very considerable increase to be made. Recently, an agricultural worker who injured his head and neck when, because of a defective rope, he fell from a trailer upon which he was loading hay, was awarded 1,320*l*. by the judge. On appeal, this sum was increased to 2,800*l*., which happened to be the sum his employers had been originally prepared to pay.

* Bird *v.* Cocking & Sons, Ltd. (1951) 2 *The Times Law Reports*, page 1260.

At the lower end of the scale, a painter, aged 52 and earning 7*l*. a week, was awarded 1,500*l*. for the loss of an eye. A riveter who fell from scaffolding and broke a leg received 850*l*.; a labourer who sustained leg injuries which would reduce his ability to obtain employment, 430*l*. Between these extremes, an apprentice engineer, aged 23, who received injuries to arm and leg which resulted in the shortening of the latter, got 3,800*l*.; and a charge-hand, aged 35, received 3,000*l*. for the loss of a leg.

In cases of death, the assessment of damages is subject to rather different considerations, governed by statute. In order that these may be properly understood, something must be said about the survival of a right of action for damages when the person injured has died as a result of his injuries. Death does not, of itself and apart from the criminal law, create any liability, and it used to be said that it was cheaper to kill an employee than merely to injure him; but this is no longer true.

At the time when railways were first developed, and there were many accidents, the relatives of those who were unfortunate enough to be killed could recover nothing, while the injured often obtained heavy damages. This led to the passing of the Fatal Accidents Act (known as Lord Campbell's Act) in 1846. Under that Act, certain close relatives, namely, husband, wife, children, parents, grandchildren and grandparents, may claim for pecuniary loss sustained by them as a result of the death. The cause of death must, however, have been such that, had the deceased lived, he could himself have brought a successful claim.

The growth of motor traffic between the wars brought about the Law Reform (Miscellaneous Provisions) Act, 1934. This provides that where there is a right of action for damages vested in a deceased person at the time of his death, that right survives for the benefit of his estate, except in certain cases not here relevant. Before the Act was passed, the deceased's executors or administrators had no right to claim damages for personal injuries inflicted upon him, except that they could claim on behalf of relatives under the Fatal Accidents Act where such injuries were the cause of death. These two Acts are quite independent of each other and are, in a sense, complementary; claims can be brought under both for the same cause of action, the only limitation being that there must be no duplication of the damages awarded.

To be able to claim under the Fatal Accidents Act, some pecuniary loss must be proved by the relatives. Thus, a wife will be allowed compensation to the extent of loss of benefit from her late husband's earnings, and a husband can claim damages in respect of the loss of the domestic services of his late wife (on the basis of having to employ a housekeeper); but a father who employs his son in his own business, and pays him the current rate of wages, can claim nothing if his son is killed, say, in a railway accident, unless he can prove that the son was contributing to his, the father's, support. The starting point in the assessment is the amount of wages that the deceased was earning at the date of his death. From this must be deducted a sum estimated to cover his personal and living expenses, and the balance is then multiplied by a certain number of years' purchase, based upon expectation of life. The resultant, or basic, sum is then subject to certain deductions, which include any award under the Law Reform Act of 1934, and pecuniary benefits which the relatives may have obtained from the death, such as inheritance under the will, or entitlement under a settlement. Payments under policies of life insurance or by benefit societies are ignored, as are pensions, and benefits receivable under the Law Reform (Personal Injuries) Act, 1948; but money paid to a widow or into the deceased's estate by way of death benefit under a contributory pension scheme must be deducted.

In claims under the Law Reform Act of 1934, it is provided by the Act that, where death has been caused by an act or omission giving rise to a claim, the damages are to be assessed without reference to any loss or gain to the deceased's estate consequent upon his death. Thus, life insurances and future earnings do not have to be taken into account; nor do the "death grant" under the National Insurance Act of 1946, or benefits receivable under the Law Reform Act of 1948. Funeral expenses may be claimed, in addition to any damages.

One of the grounds upon which damages may be claimed by the injured person himself is that of loss of expectation of life, and this, like the other grounds already mentioned, survives his death for the benefit of his estate. The estimation of such loss is, rather obviously, a difficult one, and the factors to be taken into consideration were set out by Lord Simon (then Lord Chancellor) in the House of Lords in 1940.* These factors may be summarised in this way. Expectation of life for this purpose is not to be found by statistical or actuarial methods, such as by consulting the tables prepared by the Registrar-General. "The thing to be valued is not the prospect of length of days, but the prospect of a predominantly happy life," though "the age of the individual may, in some cases, be a relevant factor." The test to be applied is an objective one —what kind of future might the deceased have enjoyed; his ability to appreciate what life might have held for him is irrelevant. The damages are to be assessed "in respect of loss of life, not of loss of future pecuniary prospects," and no regard is to be had to wealth or status. In any event, only moderate amounts should be awarded, for it is almost impossible to put a money value on the prospects of future happiness.

A good illustration of the application of both Acts is afforded by a recent case.† The deceased, who was killed in a railway accident, was a chartered accountant, aged 43, earning 1,600*l*. a year, with immediate prospects of an increase to 2,250*l*., and ultimate prospects of earning 4,000*l*. or more. He had a wife and two children, to each of whom he left 5,000*l*., and a freehold house, valued at some 3,500*l*., left to his wife. His widow was awarded, under the Law Reform Act of 1934, 250*l*. for his loss of expectation of life and 250*l*. for his pain and suffering. It was found that he expended about 700*l*. a year on his wife and children, and, as it was estimated that he would have lived about another 15 years, this amount was multiplied by 15 to make the award under the Fatal Accidents Act total 10,500*l*.

It has been suggested that it is too much to impose upon a judge alone the heavy responsibility of fixing damages, and that all cases of serious injury should be tried either by a judge with jury, or by three judges, sitting together. The legal profession as a whole appears not to endorse these alternatives, for it has had experience of the first, and, as regards the second, it is quite satisfied that any grave error can be rectified by going to the Court of Appeal, which consists, normally, of three Lords Justices. Whatever the right solution may be, there is no doubt that the Courts have a very wide discretion, and it follows that there is a correspondingly heavy responsibility for its proper exercise. Any curtailment of that discretion would have the inevitable effect of putting matters more nearly upon a rule-of-thumb basis, and it is submitted that this would operate unfairly in many cases. The present arrangement, whatever its disadvantages, does seem to be substantially satisfactory, and it is hard to see how any real improvement could be achieved.

* Benham *v.* Gambling. (1941) *Law Reports Appeal Cases*, page 157.

† Roughead *v.* Railway Executive. (1949) 65 *The Times Law Reports*, page 435.

# S.S. "LEDA" FOR NEWCASTLE-BERGEN SERVICE.

SWAN, HUNTER, & WIGHAM RICHARDSON, LTD., WALLSEND-ON-TYNE.

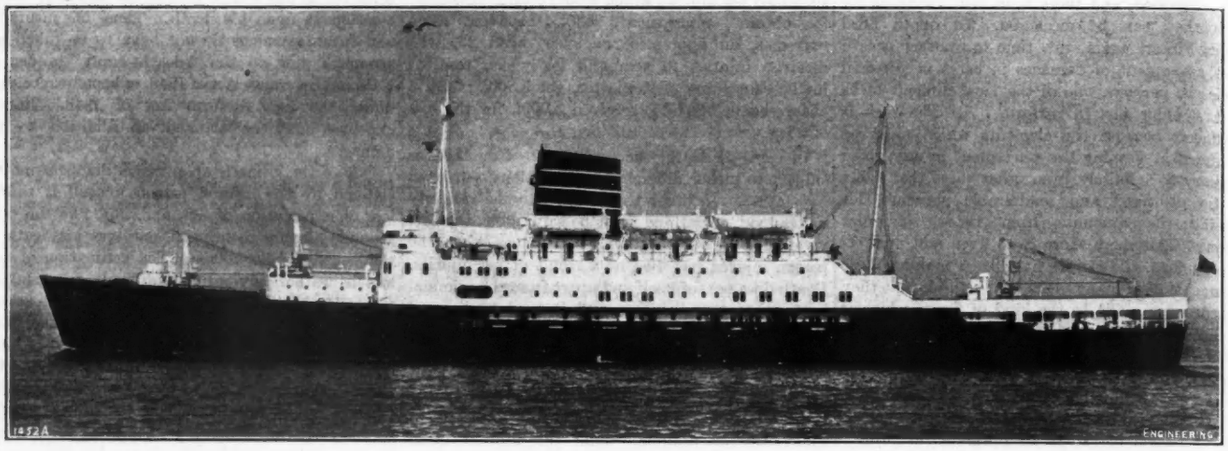


FIG. 1. VESSEL AT SEA.

## TWIN-SCREW S.S. "LEDA" FOR NEWCASTLE-BERGEN SERVICE.

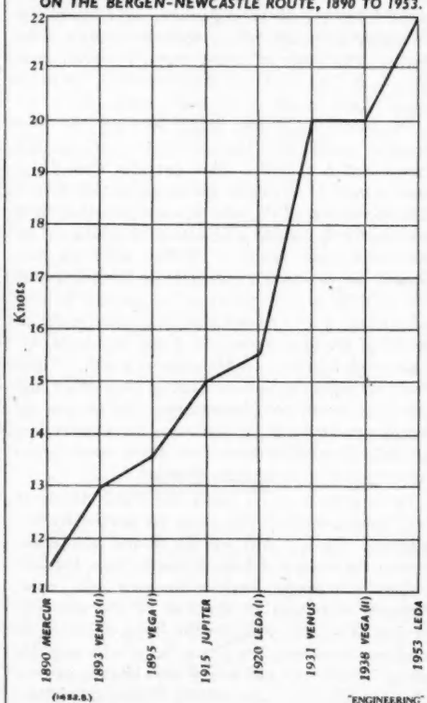
THE passenger and mail steamship Leda, which the Bergen Steamship Company put into regular service on May 2, will enable the company to provide a regular service four times a week in each direction between Newcastle and Bergen, using only two ships. The Leda's service speed is 21 knots, though a speed of over 22 knots was attained on trials; which, as Fig. 2 shows, is the first increase in speed on this route for over 20 years, though the speed has been almost doubled since 1890. The Leda has been built by Messrs. Swan, Hunter, and Wigham Richardson, Limited, at their Wallsend yard.

The layout of the ship has been arranged to meet the Bergen Company's special requirements; while retaining a high standard in the first-class accommodation, provision has been made for the growing tourist class of passenger on this route, who require inexpensive passages. Tourists can economise further, since set meals are not included in the new fares, meals being taken in a cafeteria. The Leda's main dimensions are as follows:—

| | |
|---|---|
| Length between perpendiculars ... ... ... | 410 ft. |
| Breadth ... ... ... | 57 ft. |
| Depth to upper deck ... | 30 ft. |
| Draught, approximately ... | 20 ft. |
| Twin-turbine output ... | 13,000 shaft horse-power. |
| Service speed ... ... | 21 knots. |
| Approximate gross tonnage | 7,000 |
| Passenger accommodation— | |
| First class ... ... | 119 |
| Tourist class ... ... | 384 |
| Total ... | 503 |

The first Leda, a steam-turbine ship built in 1920, was a 15-knot ship which was sunk during the war. Fig. 2 shows the way in which speeds have increased on the Newcastle-Bergen run since the Bergen Company inaugurated this regular route in 1890. The original s.s. Mercur made the passage to Bergen in 35 hours, whereas s.s. Leda completes it in 19, and the time to Stavanger, when this is the first port of call, is 17 hours. The new ship is the fastest in the Norwegian Merchant Navy. It is interesting to note the reversion to steam propulsion after the owners seemed to have settled down to motorships such as the Venus. The travelling public generally prefer steamships, and, with the Leda in service, it will be possible to make an interesting comparison between oil engine and steam turbine on this North Sea route.

*Fig. 2.* SPEED OF SHIPS ON THE BERGEN-NEWCASTLE ROUTE, 1890 TO 1953.




The Leda should be a sound commercial investment since, with a service speed of 21 knots, she will make the two round voyages a week, including two calls at Stavanger, on the eastbound voyage, and one at Haugesund. The builders may well take pride in having been given this order by the Bergen Line and, in spite of the short delivery quoted—two years—they have had the satisfaction of keeping their promise to the day. She is a fine lined ship, as Fig. 1 shows, the stern being noticeably streamlined, with clear runs for the propellers. Such lines, even for the North Sea, were justified, since it was known from the start that she was to be fitted with Denny-Brown dynamic stabilisers.* The two blades of the stabilisers are 9 ft. long. The automatic gyro control is put into operation from the navigating bridge. The Leda is the first Norwegian ship to be fitted with this device, but similar stabilisers are to be fitted in the Venus.

* See ENGINEERING vol. 170, page 577 (1950) for a description of the Denny-Brown stabiliser.

### ACCOMMODATION.

The Leda accommodates 503 passengers in all—119 first-class and 384 tourist-class—and can also carry up to 40 motor-cars. The one large-section funnel has been designed to prevent fumes and sooty deposits from the boilers troubling passengers on the boat and recreation decks. Thermotank, Limited, carried out tests for this purpose. The principal decks are the navigating bridge and boat deck, upper and lower promenade decks, upper deck and main deck. The structure has been mainly welded, except for the frames and beams, which are riveted. The deck house on the boat deck and the masts are of aluminium alloy. Model tests of the hull form were carried out in the National Physical Laboratory's tank. The three holds for cargo and Nos. 1 and 2 lower 'tween deck spaces forward are insulated, with trunked hatches to the weather decks. MacGregor steel hatch covers are fitted at these decks. The three 3-ton electric jib cranes for handling cargo were supplied by Messrs. Thos. B. Thrige, Limited, Denmark. This is a very popular type of crane in Scandinavia. The crane operator always faces the hook, and rotates round with the crane. The jibs, when not in use, are stowed horizontally from the base, so the ship's cargo-handling gear is inconspicuous when at sea. The fire-fighting and detecting equipment is of the most modern type, and division by bulkheads and fireproof doors is very comprehensive.

There are eight lifeboats, which are of aluminium and are housed in Welin-MacLachlan gravity davits. The bridge is provided with almost every possible modern aid to navigation and safety of life at sea. The navigational aids include a direction finder; electric log; course recorder; two radar sets, each with its own scanner (these have different ranges and are on different wavelengths—10 cm. and 3 cm.—in the expectation that under difficult aerial conditions one or other will function well); a Sperry Gyropilot for automatic steering; echo-sounding apparatus; and a Decca Navigator, which will function as far as Stavanger. The safety devices, in addition to the bridge controls for the Denny-Brown stabilisers, include a "Rich" smoke-detecting system; a Grinnell automatic sprinkler and fire-alarm system; and Stone's hydro-pneumatic control system for the 12 watertight doors fitted in all the main bulkheads below the upper deck. Just aft of the navigating bridge is a commodious chart room, and aft again are the Captain's quarters. The quarters for the other deck officers and the engineer officers are farther aft on the boat deck, together with the wireless officers' accommodation.

First-class passengers are accommodated on the upper deck as well as on the upper promenade and lower promenade decks. Half the cabins are provided with shower and toilet. There are also four

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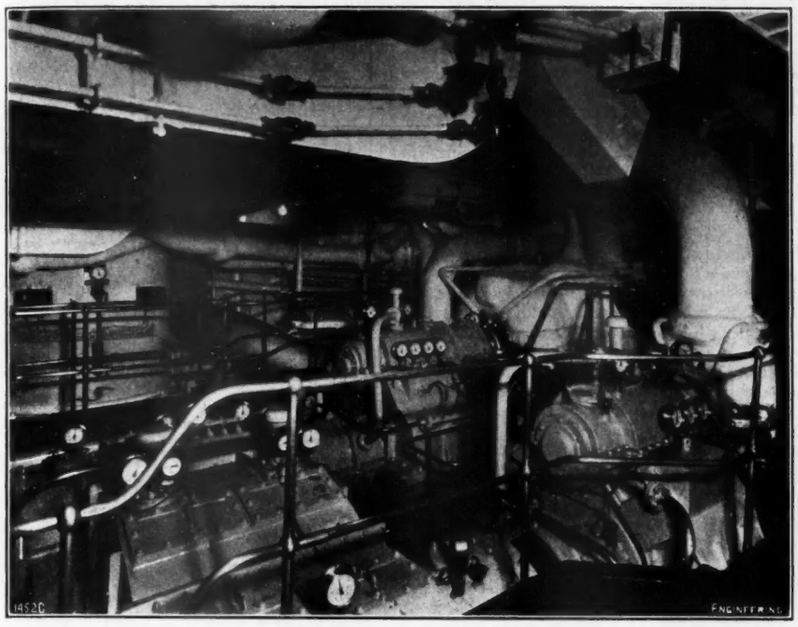

FIG. 3. ENGINE ROOM.

FIG. 4. TOURIST LOUNGE, STARBOARD SIDE.

cabins *de luxe*. Turning to the public rooms, the upper promenade deck contains an observation lounge, which, with scarcely visible glass partitions, extends the full width of the ship and contains large observation windows all round. There are extensions aft, comprising a bar lounge on the port side and a writing room on the starboard side. Astern of the passenger accommodation is the open promenade deck with a deck bar. The dining room, located amidships, and the first-class hall, are on the lower promenade deck, with the entrance hall, purser's office and shop another deck down. The panelling of the public rooms is principally of plain wood, decorated in places by contemporary Norwegian artists or hung with pictures.

The tourist accommodation is spacious and attractive. On the lower promenade deck, immediately aft of the first-class dining room, are the tourist lounge (Fig. 4), a writing room and a bar, separated only by light partitions. Aft again is a good promenade deck. Down one deck is the hall and restaurant, run on the self-service cafeteria system—a system which has already had a successful trial on the newest of the company's boats running the daily postal service from Bergen to the North Cape and beyond. Feeding on the cafeteria principle economises space and adds considerably to the number of cabins available. Cabins for from two to ten passengers are on this and one lower deck. The main pantry and galley fitted out with the latest types of electrical cooking equipment are adjacent.

## MACHINERY.

The main propelling machinery, together with the boilers, etc., have been constructed by the Wallsend Slipway and Engineering Company, Limited. Fig. 3 shows a view of the engine-room. There are two sets of geared turbines, the service power being 13,000 shaft horse-power at 150 r.p.m. of the propeller. Steam is supplied at a pressure of 450 lb. per square inch and at a total temperature of 800 deg. F. The gearing, which is of the double-helical type, consists of one main wheel on each propeller shaft, which meshes with two main pinions driven, respectively, by the high-pressure and low-pressure turbines working in series through a double-reduction gear. At the above power the speed of the high-pressure turbines is about 6,000 r.p.m., and that of the low-pressure turbines about 3,500 r.p.m. The high-pressure turbines are wholly impulse, as are also the astern turbines, which are accommodated in the low-pressure turbine casings. The low-pressure ahead turbines are of the impulse reaction type. Each astern turbine comprises three two-bucket impulse wheels in each low-pressure turbine casing and is designed to develop 70 per cent. of the ahead power. All bearings for both the turbines and the gearing are provided with forced lubrication, and this also applies to the main thrust blocks, which are of the Michell type. Michell journal-type bearings are used on the propeller shafts. The propellers are of solid manganese bronze, each with four blades.

The main condensers are of the Weir regenerative design, suspended from their associated low-pressure turbine casings. The condensers are designed to maintain a vacuum of 28½ in. of mercury with the barometer at 30 in. and the sea-water temperature 60 deg. F. The condensate from the main condenser is returned to the main water-tube boilers through a closed-feed system of Messrs. G. and J. Weir's design. The main steam generating installation consists of two Babcock and Wilcox integral-furnace type boilers, fitted with superheaters and tubular air heater. The water walls of the furnace are covered with a chrome-ore refractory lining. These boilers supply the main turbines, electric generator turbines, air ejectors and turbo feed-pumps. An oil-burning vertical Cochran boiler is also installed, to supply steam at a pressure of 120 lb. per square inch for auxiliary purposes. It operates with natural draught. The two main boilers are arranged to burn oil only, on the Wallsend-Howden pressure system. Boiler feed-water control is automatic.

The auxiliary machinery generally is electrically driven, current being supplied by three Brotherhood turbo-generators, each having a direct-current output of 350 kW at 220 volts. The Drysdale pumps—main and auxiliary circulating, emergency fire and bilge, ballast, general-service, fresh-water, bilge and sanitary pumps—are all electrically driven. The electrically-driven forced-lubrication and oil-fuel transfer pumps are of the Imo type, supplied by Mirrlees (Engineers), Limited. This is a type of pump greatly favoured in Scandinavian countries. The auxiliary generators are housed in a separate compartment forward of the main engine-room. The machinery throughout is of the most modern design and has been constructed to fulfil Det Norske Veritas survey.

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INDIAN FIVE-YEAR ROAD PLAN.—Sanction has been given for a five-year road-development plan for India for which an allocation of Rs.270 million (20,250,000*l.*) has been made. The plan involves the construction of 450 miles of new roads on the national highway system, together with improvements to about 2,200 miles of existing roads; 43 new large bridges will be built, the largest at a cost of Rs.100 million. A further allocation of Rs.60 million has been made for the development of inter-State roads.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—The Alexander Pedler Lecture on "The Life and Times of Sir Richard Gregory," held under the auspices of the British Association for the Advancement of Science, will be delivered by Sir Harold Hartley, K.C.V.O., F.R.S., at the Royal Institution, 21, Albemarle-street, London, W.1, on Thursday, May 28, commencing at 6 p.m. Admission will be by ticket, obtainable without charge, from the secretary of the Association, Burlington House, London, W.1.

## THE HYDRAULICS RESEARCH STATION.

THE equipping of the Hydraulics Research Station at Wallingford, Berkshire, is progressing, though not, perhaps, as rapidly as some may wish. Since we reviewed the work of the Station on page 825 of the issue of December 26, 1952, other tanks and flumes have been added, but the main hall, which is to be the heart of the station, is barely started. It is to be 300 ft. by 200 ft., and is designed so as to be capable of extension in either direction. An interesting feature of the design is the provision in the ceiling at regular intervals of camera emplacements, so that experiments on the behaviour of models may be photographed to give a continuous record, and the behaviour of an estuary, for example, over several years, can be depicted by means of a model emulating the tides and seasons, recorded by a film of a few minutes showing time.

Two tanks, each 120 ft. by 80 ft., are now in existence, and both are fitted with wave-making machinery which is adjustable for speed, length of stroke and direction of propagation, while one of the tanks is provided with a surrounding channel in which is located a reversible propeller pump of 70 cusecs capacity, so that cross-currents may be simulated. In one of these tanks, experiments in connection with the harbour of Lyttelton, in New Zealand (the harbour for Christchurch, South Island), are being carried out, with a view to determining the most satisfactory layout for extensions in relation to wave and silting problems. In one of the glass-sided flumes fitted with a wave-making device, which also simulates the daily and seasonal tides, experiments to determine the action of waves and the effect of sea-walls (of different profiles) on beaches are continuing.

Two interesting developments in respect of equipment are taking place, but since development is continuing and the outcome will be the subject of patents, it is not possible, at this stage, to give any detailed information. One development, however, concerns current meters. The necessity of possessing a current meter which will accurately record almost inappreciable velocities is the cause of this work being undertaken. An electronic current meter has been built, and is now under test, which dispenses with the usual contact wire and is, in consequence, practically frictionless. Another development is a self-regulating weir, which has no moving parts whatever, and which, on test, was shown to be capable of maintaining a constant water level in a tank only 6 ft. by 6 ft. when the input to the tank was varied between 0·5 and 5·0 cusecs as fast as the control valve could be opened or closed. This development will provide a means of keeping an up-stream water-level constant during the calibration of notches and meter-flumes, but clearly, on a large scale, it would be invaluable when installed above control points in rivers and canals. Moreover, the device does not "gobble" water, and so give rise to fluctuations, but instantaneously and smoothly varies its discharge to suit the water level which otherwise would prevail were it not self-regulating.

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CONGRESS ON FORESTRY AND THE TIMBER INDUSTRIES.—A European congress on productivity in forestry and the timber industries will take place at Stuttgart from Monday, September 7, to Saturday, September 12, 1953, under the auspices of the Organisation for European Economic Co-operation and the Mutual Security Agency. The aim of the congress will be to examine problems which arise in connection with improving productivity in these industries, and to make practical proposals for their solution. Particular attention will be given to the question of utilising the experiences of national and international missions sent to the United States. There will be two plenary sessions on general problems, and six technical sessions, dealing, respectively, with wood production, logging operations, sawing industries, timber industries, the utilisation of waste products, and conditioning and marketing arrangements. Applications to attend and requests for further information should be sent to the secretary of the congress, Mr. Eberhard von Bernuth, Luisenstrasse 3, Bonn, not later than July 31. Final detailed programmes will be forwarded to all participants at the beginning of August.

## LABOUR NOTES.

FINDINGS that there was no victimisation by the Austin Motor Company, Limited, and that the strike of the vehicle builders at the firm's Longbridge works at Birmingham was unconstitutional, were recorded by the court of inquiry set up by the Minister of Labour to investigate the dispute. The court was appointed at the request of the National Union of Vehicle Builders, to which the men belonged, and consisted of Sir John Forster, K.B.E., Q.C. (chairman), Mr. A. J. Espley, C.B.E., and Mr. A. G. Tomkins, C.B.E. Its public hearings in London occupied eleven days and its report was published as a White Paper (Cmd. 8839, H.M. Stationery Office, price 1*s.* net), on May 12.

A detailed history of the dispute and the points which counsel for the two sides agreed were the main issues involved are set out in Part I of the report. The stoppage arose out of the dismissal by the company of 700 workpeople and 100 office staff in August last year, owing to redundancy. Those discharged included Mr. J. P. McHugh, who was looked upon by the union as its chief shop steward at Longbridge works. It was part of the union's case that the firm had undertaken that no men from outside should be taken on until the men discharged had been re-engaged. The company stated that it had agreed to give preference to redundant men as far as it could. As a result of Mr. McHugh not being re-employed, the union called a strike, which commenced on February 17. At the peak of the dispute, about 12,000 men at the works were idle, including 2,377 vehicle builders on strike. The company announced on March 23 that it considered the strike at an end and that men who did not return to work by the following Friday would be deemed to have left its service. This resulted in the dismissal of 1,583 men.

In the court's comments and conclusions, which are contained in Part II, it is stated that the undertaking given by the general works manager at Longbridge, Mr. J. R. Edwards, on behalf of the company, at a meeting with union officials on August 14, 1952, was that, with the exception of specialists, no "new" labour would be engaged during the period over which discharges due to special redundancy would take place; that this period would not exceed from three to four weeks; and that thereafter consideration would be given as far as possible to former employees of the company. This undertaking was honoured by the company. The dismissal of Mr. McHugh among other redundant employees on September 5, 1952, was neither irregular nor selective in form, and could not be attributed to victimisation on account of his trade-union activities.

Other findings by the court were that Mr. G. Evans, a district organiser of the N.U.V.B., did seek, at a meeting with Mr. Edwards on September 5 about the dismissal of Mr. McHugh, to obtain preferential treatment for him, although such preferential treatment was not in accordance with the union's national policy. The strike called on February 17 was unconstitutional, because it was not in accordance with the union's current rules. With regard to the company's notice of March 23 and the discussions that followed it, both the company and the union adopted a regrettably inflexible attitude and neglected reasonable possibilities of compromise. Finally, the court expresses the hope that both sides would now take steps to close the unfortunate dispute and make every endeavour to achieve the good industrial relations so essential in modern industry.

On April 17, the fourth day of the hearing before the court, efforts were made to bring the strike to an end. The company stated that there could be a staggered return to work by the men if they applied for engagement through their local employment exchanges. All workpeople previously employed by the company, with the possible exception of about two to three hundred, would eventually be found jobs. This offer was rejected by the union on April 23, but, on May 14, after the conclusion of the hearing, there was a mass meeting of the men, at which, on the advice of the union's executive council, it was agreed to accept the company's terms.

Wage rates for women employed in the engineering group of industries, of whom there are between 700,000 and 800,000, were discussed at some length by the delegates to the annual conference of the national committee of the Amalgamated Engineering Union at Eastbourne on May 7. Eventually, a resolution was approved calling upon the union's executive council to press for a minimum rate of pay for women "of an amount not less than that of the adult male labourer." During the debate on women's wages, a woman delegate from a London division complained that, in the past, wage increases granted to women engineering employees had always been a little smaller than those obtained for men. Last year, for example, women received a farthing an hour less than the men. It ought to be realised by everyone, she stated, that women were working in the engineering industries to earn a living and that, whether men employees liked it or not, they were there to stay. Another speaker urged that if the union asked for only the same increase for women as for the men (15 per cent.), it would be a serious retrograde step, as it would have the effect of still further widening the gap between men's wages and those of women employees.

Some delegates, during the debate, pressed for an assurance that the executive council would not accept any agreement on wages which gave an increase of a lesser sum to women than to men, and Mr. Jack Tanner, the President, promised that the council would do its best, but said that no definite assurance could be given. It was agreed that the council should take up with the employers the question of setting up a grade scheme for women employees in these industries. The national committee was informed that a meeting of officials from each of the five unions catering for women engineering operatives would be held at an early date, to consider the question of making a wage claim on their behalf. In addition to a demand for a 15 per cent. increase for men engaged in general engineering work, the committee decided to claim increases of a similar percentage for skilled men engaged in Government engineering establishments, the motor-vehicle repair industry, and municipal passenger-transport undertakings.

A definite assurance was given on the following day by the President that whenever engineering operatives objected to the use of stopwatches, whether in connection with the working of payment-by-results schemes, or for any other reason, they would have the full support of the executive council. There had been general criticism from the delegates regarding the use made of stopwatches in engineering works, but a resolution calling for action by the union to prevent their use was withdrawn after this assurance had been given from the chair. The mover of the resolution had affirmed that the use of the stopwatch was growing and that it was being applied to sections of industry where its use would at one time have been quite impossible. Other delegates affirmed that the men in their areas would not allow stopwatches.

The necessity for all piecework prices to be mutually agreed to by employers and workpeople was referred to by a member of the executive council, Mr. J. R. Scott. He reminded the delegates that, although the executive council always supported members who did not want a stopwatch used in connection with their work, there were occasions when it was useful to the employees themselves to have their operations accurately timed. A motion advocating support for the principle of a national wage policy was vigorously attacked and withdrawn. Another motion, suggesting the negotiation of a sliding-scale rate of wages based on a "satisfactory" cost-of-living index, also proved unacceptable to the delegates, and was heavily defeated on a vote being taken. It was decided that the union's leaders should approach the Government regarding the drift of workpeople from Wales to London.

# BRIGHTON "B" 330-MW POWER STATION.

FIG. 1. EXTERIOR OF STATION FROM THE SOUTH-EAST.

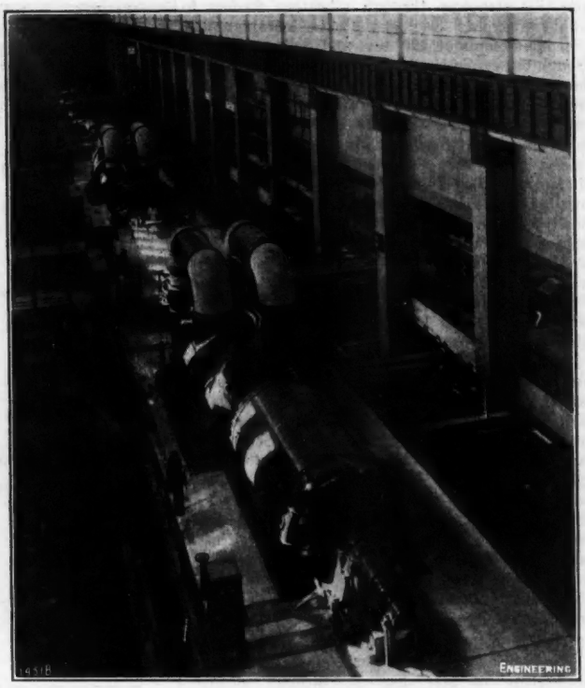


FIG. 2. TURBINE ROOM.

## THE BRIGHTON "B" POWER STATION OF THE BRITISH ELECTRICITY AUTHORITY.

THE Brighton "B" power station of the British Electricity Authority, the first unit of which was commissioned in December, 1952, forms an important addition to the generating capacity of the South Eastern Division and will in future play an increasing part in meeting the growing electrical load in that area. Work on the site, which lies on Shoreham Harbour, was begun in November, 1947, under the auspices of the Brighton Corporation, the chief engineer and manager of the Electricity Department at that time being Mr. H. Pryce-Jones, who was responsible for the general design in association with the Central Electricity Board. Construction was subsequently continued under the Authority, Mr. W. C. Parker being the Divisional Controller, and Mr. W. B. Shannon, the Chief Generation Engineer (Construction), while the consulting engineers for the general civil engineering and building work were Messrs. L. G. Mouchel and Partners, Limited, 39, Victoria-street, London, S.W.1, Sir William Halcrow and Partners, Caxton-street, London, S.W.1, being responsible for the circulating-water system and harbour reconstruction. At the present time two 52·5 MW sets with the associated steam-raising plant are in operation, while two more sets of the same capacity are under construction. The station will be completed later by the installation of two 60-MW units, giving a total installed capacity of 330 MW.

A photograph of the station taken from the south-west is reproduced in Fig. 1. It is built on pile foundations and consists of a steel frame with brick filling, the design having been prepared by Mr. J. H. Somerset and approved by the Fine Arts Commission. The boiler house is 900 ft. long, by 100 ft. wide and 115 ft. high, and the turbine room, including the loading bays, 850 ft. long by 60 ft. wide and 81 ft. high. The single chimney, prominent in Fig. 1, is 350 ft. high and its internal diameter decreases from 33 ft. 2 in. at the base to 24 ft. 4 in. at the top. Eventually, a second chimney will be added. The station is connected with the Southern Cross grid substation by a 10-ft. diameter tunnel which was driven under Shoreham Harbour. The work of constructing the foundations and superstructure was carried out by Messrs. Holloway Brothers (London), Limited, 157, Millbank, London, S.W.2, and the steelwork was supplied by Messrs. Redpath Brown, Albion-road, Edinburgh, 7. The roads, wharf and circulating-water system were constructed by Messrs. Bierum and Partners, Limited, Harrow, Middlesex. As there has recently been some criticism of the extravagant lay-out of British power stations it may be mentioned that the capacity-area ratios of the turbine room and boiler house are 6·5 kW and 3·7 kW per square foot, respectively, and that the volume of the main buildings, excluding the precipitators and administration block, is equivalent to 55 cub. ft. per kilowatt.

Coal is brought in by sea and is at present discharged by two unloaders, each with a capacity of 300 tons per hour, on to conveyors the total length of which is about 3,200 ft. These conveyors, of which there are now eight, take coal to the boiler-house bunkers or to a 100,000-ton store which is equipped with a transporter for trimming and reclaiming. The contractors for this portion of the plant were Messrs. Mitchell Engineering, Limited, 1, Bedford-square, London, W.C.1. The present steam-raising plant consists of three boilers of the high-head type, constructed by Messrs. Babcock and Wilcox, Limited, Farringdon-street, London, E.C.4, and are designed to burn pulverised coal from the East Midlands, Northumberland, Durham and Kent fields. Six similar boilers are under construction. The fuel is supplied from the bunkers to E-type mills, of which there are three for each boiler with an individual rating of 16,570 lb. per hour. From them the pulverised coal is transmitted to 12 vertical inter-tube burners, situated near the top of the boiler furnace and firing downwards. In addition, each boiler is equipped with four automatic-ignition pressure-atomising oil burners for lighting-up purposes. These burners are ignited by a high-tension spark from a transformer and retract automatically when the oil pressure is shut off.

The boiler furnaces, the volume of which is 23,500 cub. ft., are provided with Bailey block walls, which account for 4,350 sq. ft. of the total boiler heating surface of 9,225 sq. ft. The single drum is 41 ft. 6 in. long and has an internal diameter of 54 in., while the overall height of the boiler is 115 ft. The superheaters, the heating surface of which is 13,090 sq. ft., are of the Babcock two-stage multi-loop type, attemperators of the surface pattern, which are automatically controlled on the Bailey system, being placed between the primary and secondary sections. The economisers, which have a heating surface of 18,500 sq. ft., are also of the multi-loop type and are arranged in two banks of three sections. There are two regenerative air heaters of the Howden-Ljungstrom type on each boiler, the individual heating surfaces of which are 33,100 sq. ft. The output of each steam-raising unit at the maximum continuous rating is 320,000 lb. per hour at a pressure of 950 lb. per square inch and a temperature of 925 deg. F. at the superheater outlet. The feed temperature to the economiser is 385 deg. F. and the thermal efficiency when burning fuel of a net calorific value of 10,000 B.Th.U. per lb. is 88 per cent. Equipment of the Hagan type is installed for automatically controlling the rate of combustion. It operates by making adjustments to the fixed vanes in the case of the forced-draught fans, to the hydraulic couplings in the case of the induced-draught fans and to the dampers in the primary air discharge ducts. The two forced-draught fans are driven by 121-h.p. motors and each has an output of 57,500 cub. ft. per minute, while the two induced-draught fans are driven by 297-h.p. motors and each has an output of 90,000 cub. ft. of air per minute. Each primary-air fan has an output of 13,000 cub. ft. per minute. All these fans were manufactured by Messrs. James Howden and Company (Land), Limited, 195, Scotland-street, Glasgow. Each boiler is equipped with 22 steam sootblowers, which are hydraulically operated on the Babcock-Lockheed automatic sequence control system. The blowers in the furnace and superheater are of the single-nozzle retractable type, while those in the air heaters are of the fixed pattern. A view in the boiler house is given in Fig. 3, on page 666, while the boiler-control panel is illustrated in Fig. 4.

Messrs. Babcock and Wilcox were also the main contractors for the ash- and dust-handling plant. The ash from each boiler is discharged into a hopper from which it is extracted into a pit at intervals on the Hydrojet system. From this pit it is removed by grabs, transferred to a second

hopper and led through vibratory feeders to one of two inclined belt conveyors which raise it about 85 ft. to an elevated structure. It is delivered from this structure through vibratory feeders to radial conveyors. Each of the latter has an angular movement of about 120 deg. and delivers the ash through telescopic chutes to either lorries or barges. The flue gases are cleaned first by passing them through a mechanical collector and then through Sturtevant electrostatic precipitators. The latter, which are of that firm's standard tubular type, are divided into three self-contained sections by concrete partitions. Each section can be isolated both by inlet and outlet dampers as well as electrically, and can thus be closed down for maintenance while the full volume of gas is dealt with by the other two. The dust-laden gas is first circulated downwards round the outside of banks of tubular electrodes and then upwards through these electrodes to the walls. The solid matter adheres to these walls owing to the application of a high electric potential, and the cleaned gases pass on to the flues. Rapping gear is provided to maintain the tubes and electrodes in a reasonably clean state; the necessary high-tension unidirectional current is obtained through a step-up transformer and mechanical rectifier. Two sets of this equipment are installed in a house between each pair of boilers the sets being interconnected on the output side so that they can supply either precipitator. The dust is collected by Hydrovac equipment and, after passing through cyclones, is automatically discharged into a hopper. It is subsequently mixed with water and passes on to the ash conveyors.

Steam from the boilers is supplied to the turbines at a pressure of 900 lb. per square inch and a temperature of 900 deg. F. through chrome-molybdenum steel pipes, manufactured by Messrs. C. A. Parsons and Company, Limited, Newcastle-on-Tyne; the valves in these pipes were constructed by Messrs. Dewrance, Great Dover-street, London, S.E.1. The turbines, of which two are in operation and two more are in course of erection, were constructed by Messrs. Richardsons Westgarth and Company, Limited, West Hartlepool, and have an output of 52·5 MW at 11 kV when running at 3,000 r.p.m.

These turbines, which are illustrated in Fig. 2, on page 665, are of the three-cylinder type, the high-pressure cylinder containing one impulse and 24 reaction stages, the intermediate pressure cylinder 19 reaction stages and the low-pressure cylinder, which is of the double-flow type, six reaction stages in each half. They exhaust into twin condensers, which were also manufactured by Messrs. Richardsons Westgarth, and have a total cooling surface of 50,000 sq. ft. Cooling water is drawn from the harbour by four pumps, each of which is driven by a 570-h.p. motor and has an output of 47,500 gallons per minute against a head of 28·5 ft. The condensate is withdrawn from each twin condenser by two extraction pumps, each having an output of 875 gallons per minute against a discharge pressure equivalent to a head of 185 ft. It then passes successively through a drain cooler, low-pressure heater, gland heater, de-aerator, feed pumps, and three high-pressure heaters to the boilers, the final temperature of the water at the economiser inlet being 385 deg. F. There are two de-aerator extraction pumps on each set with a capacity of 918 gallons per minute and a generated head of 90 ft. and four electric and two steam-driven feed pumps for the three sets, each of which has an output of 917 gallons per minute and discharges at a pressure of 1,266 lb. per square inch. All these pumps were manufactured by Messrs. Mather and Platt, Limited, Manchester. No evaporators are included in the system, but make-up water from the town's mains is treated by the Deminrolit process in plant supplied by Messrs. Permutit, Limited, Chiswick, London, W.4.

The main alternators, each of which was also constructed by Messrs. Richardsons Westgarth, are solidly connected to 60-MVA, 11·8/141·6-kV English Electric transformers. The secondaries of the transformers associated with the first two sets are connected by overhead lines to the 132-kV grid in the Fishergate substation, while the other four will eventually be joined by cables operating at the same voltage and run through a tunnel to the adjacent Southern Cross substation. It should be noted that there is no main switchgear on the power-station site. In addition to the main transformers, each alternator is connected to a 5-MVA, 11·8/3·3-kV unit transformer, of Metropolitan-Vickers manufacture. The same firm also supplied two 6-MVA, 33/3·3-kV house transformers, the primaries of which are connected to the 'bus-bars in the "A" station, and a number of smaller units with a secondary voltage of 415 volts from which most of the auxiliary motors with outputs below 90 h.p., as well as the lighting system, are fed. Direct-current is supplied from a 400-ampere-hour 240-volt Chloride battery. The 3·3-kV switchgear, which is also of Metropolitan-Vickers manufacture, is of the bulk-oil air-break type with a rupturing capacity of 100 MVA.

## BRIGHTON "B" 330-MW POWER STATION.

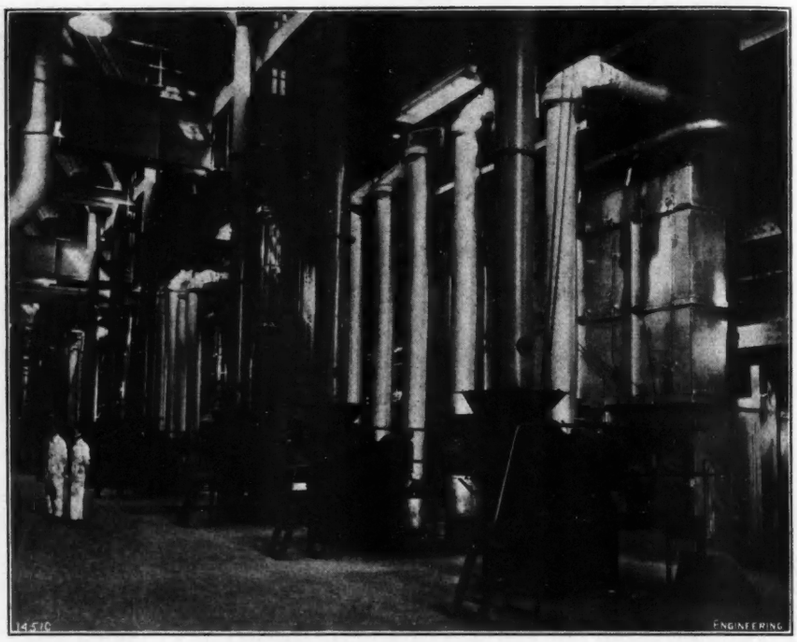

FIG. 3. BOILER HOUSE.

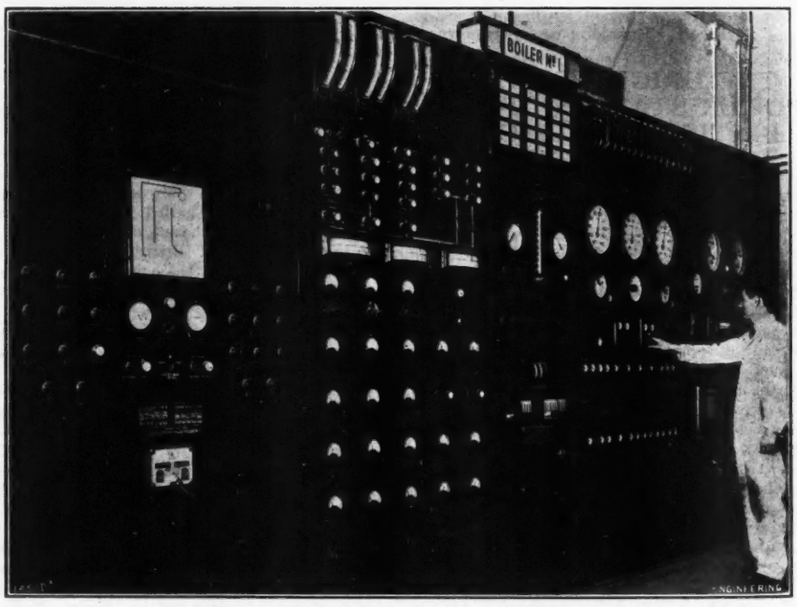


FIG. 4. BOILER-CONTROL PANEL.

ELECTRIC POWER STATIONS IN BELFAST.—The 30-MW set which was formally inaugurated by the Lord Mayor in the East Station at Belfast on Wednesday, May 6, completes a scheme which was commenced 30 years ago and brings the capacity of the station up to 174·75 MW. It is hoped to open next year the first section of the West Station, which will accommodate two 30-MW and two 60-MW sets together with the necessary steam-raising plant.

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EARLY AUSTIN SEVEN CAR AT THE SCIENCE MUSEUM.—On Monday, April 27, one of the six prototype Austin Seven motor-cars built in 1922 was presented by Colonel A. C. R. Waite, M.C., on behalf of the Austin Motor Company, Limited, to the Science Museum, South Kensington, where it will remain on view as a landmark in the evolution of road transport. Production of the Austin Seven began in 1923 and continued for 14 years, during which time 300,000 cars were constructed, with only minor modifications during the whole of the period.

# PRESIDENTIAL ADDRESS TO INSTITUTE OF FUEL.*

By DR. G. E. FOXWELL, F.Inst.P., M.Inst.Gas E., M.I.Chem.E.

THE predominant characteristic of industrial organisation is likely to be collectivism. Experience has shown that it is easy for a political party in power to bring vast industries under State control or ownership in such a way that "unscrambling" is exceedingly difficult. Collectivism in one form or another has completely replaced *laissez-faire* as the principle behind the relations of the State with industry. This is not only a British conception, it is world-wide. Modern industry requires immense capital. Basic industries must conduct their operations on a large scale. Unregulated production and unregulated competition are out of favour on economic grounds. We may expect increasing, rather than decreasing, State control of basic industries and services; that has been the trend of development over the whole industrial era. The fuel-producing industries are therefore no longer concerned with trading upon the principles of private enterprise; they must collectively regard themselves purely as corporations supplying a service to the nation irrespective of their sectional interests as erstwhile industries in their own right.

The fear of exploitation of employees that lies below the political surface has led to the belief that periods of unemployment are due to the operations of private capitalism and that only by State control of industry can full employment be guaranteed. Those who believe that the State can guarantee full employment live in a fool's paradise. We can only keep ourselves employed if we sell abroad a high proportion of the goods we manufacture. Our ability to do this depends partly on our own efforts and partly on world conditions. Because so much of the business of the world is now done between governments, it seems likely that there may be sound practical reasons for State co-operation—not necessarily ownership—in industry in some form or other.

The difficulties of effectively managing the very large corporations which now control the fuel industries are considerable. Fuel conservation must start at the production end. Producers recognise the duty of conducting their processes efficiently. It will not always be likely that the sectional interest of each fuel production unit will coincide with the interests of others or of the nation.

A yardstick is needed against which the efficiency of the nationalised fuel-producing industries can be measured. In private enterprise the yardstick was profits earned in the competitive market. The Nationalisation Acts appear to consider that an effective test is that the accounts shall balance, taking one year with another. One example of the fallacy of that yardstick is that employees in the nationalised industries may secure, at the expense of the consumer, increases in pay that have no relation to the cost of living. It is now fatally easy to raise prices. The review of the proceedings of these industries by consumers' councils provides a useful if limited check on some of their activities. If the present arrangements were wholly satisfactory would there be so insistent a demand for accountability to Parliament?

It appears that the method yet remains to be found whereby the skill with which the fuel-producing industries are managed can be made apparent without interfering with day-to-day management. Those put in charge must have the same powers and responsibilities as appertain to the management of private enterprise. But since human beings are fallible some particular and appropriate means must be found for judging the ultimate result, other than a Minister and his staff who may not be sufficiently experienced in the industry concerned. The nationalised industries are to-day young, enthusiastic and are managed mainly by those who have been brought up in them. In common with the rest of nature, however, human affairs tend in the course of years to sink to a dead level of mediocrity unless they are energised from time to time. Examples may be quoted of the difficulty of leaving decisions to individual fuel industries, since each industry will naturally regard its own interest as paramount. Taking first the question of tariffs. The gas industry has been disturbed of late years by the possible cost of supplying the demand for gas for space-heating. The electricity industry, where the load factor is even more difficult, has deliberately sought the peak demand loads of space-heating, water heating and cooking. All industries defend their tariff policies convincingly, but should there not be a court of knowledgeable professional people from whom the Minister could obtain guidance?

Turning now to production policy: (*a*) The Simon Committee reported that solid smokeless fuel should carry the main space-heating load. The thermal efficiency of the carbonising process in a modern plant is of the order of 80 per cent., and it has been pointed out that the extension of the carbonising process provides a valuable means of saving fuel. The gas industry seems disposed to reduce its output of solid smokeless fuel; the coal industry has taken no effective steps on an industrial scale to produce the necessary fuel nor is there any evidence that either industry would do so even if the plant were available. (*b*) The electricity industry, with an overall thermal efficiency of about 20 to 25 per cent. is only now beginning to work in co-operation with industries that can use their steam both for power and process; nor does the electricity industry appear disposed to increase greatly its thermal efficiency by the use of pass-out or back-pressure steam. (*c*) Adequate steps should be taken to develop forms of railway traction more efficient thermally than steam. (*d*) The best coking coals are rapidly approaching exhaustion; should they not be reserved for the manufacture of metallurgical coke?

These are but examples of the type of problem in fuel utilisation for which the industries concerned have their own solution, but which raise the doubt whether in a collectivist society there should not be Government direction under skilled advice on the policy to be pursued. There seems to be little point in bringing all these industries under Government control if they are to be left to run on much the same lines as before.

Industries in which the fuel cost is an appreciable proportion of the total cost may be expected to seek for more efficient ways of using fuel. The larger firms employ fuel technologists to guide them. Many firms—large, medium and small—are in need of advice. The success of the Ministry's fuel advisory service augurs well for the extension of the scheme as proposed by the Ridley Committee, providing it is run on sound lines. It is not the function of an advisory service to conduct research, nor should it expect the research associations to be its analysts or its consultants. If such a service is set up by industry it must be self-contained and staffed with well-trained fuel technologists in sufficient numbers who would apply established knowledge to the improvement of heat and power utilisation in industry.

For many important industries, the cost of fuel is a small proportion of the total costs. It is therefore unlikely that industry in general will improve and maintain its standard of fuel utilisation unless it is actively assisted, persuaded or even coerced to do so. Assistance can be provided through taxation relief; persuasion through education and tariff adjustment. But history prompts us to inquire whether a voluntary fuel advisory service will be sufficient. From 1802 onwards some 40 Factory Acts were passed in the nineteenth century regulating compulsorily the conditions of work in factories. Manufacturers would not safeguard the health or safety of their employees until compelled to do so. No advance was made until, in 1833, four paid Government inspectors were appointed to enforce the law. To-day, inspection on the basis of compulsion is the rule in factories, education, health, and so on. Is not our fuel position sufficiently grave for there to be established some national system of fuel-utilisation inspection by paid inspectors, working wherever possible by agreement, but with background powers, similar to those of smoke inspectors?

The tariff weapon could be used in this cause, but would require careful management. Through it, an industry or a Government can dictate the course of fuel usage without issuing directions or passing laws. It works a little on the lines of the purchase tax. Should the responsibility for fixing fuel prices remain in the hands of the industries concerned? By taking control of the production of coal, gas and electricity, the State has accepted responsibility for the fuel services. Can it therefore stand aside and permit direct waste or improper use to continue? Is not that the antithesis of the principle of collectivism under which the fuel industries have been nationalised?

Let me digress to record valuable contributions made by the nationalised industries towards economy in fuel in the increasing use of material formerly discarded. Among these are the utilisation of slurry at the colliery, the use of high-ash powdered fuel for boiler firing, and of low-grade fuels generally by the electricity industry. The Fuel Research Station, regarding non-coking or poorly-coking coals as "low-grade" for the purposes of metallurgical-coke production, is studying how to use them for that purpose. The British Coke Research Association has a similar objective. The gas industry has plans for making gas from coals that by reason of their rank, size or ash content would not have been considered suitable previously, and is using coke breeze in boilers with a thermal efficiency of 75 per cent. and in this way and from waste heat is producing not only all the power required by the gasworks, but in some cases a surplus for sale to the electricity industry. The gasification of coal dust already achieved in Germany is being studied at the Fuel Research Station and by the gas industry. One looks forward to the use of colliery refuse in gas producers to heat coke ovens, thus liberating all the gas for town purposes.

The need for increased production of fuel has been noted. There will be little disagreement with the proposition that in order to maintain full employment in ordinary times it will be necessary to invest large sums in new plant—much larger sums than are being invested at present. Sir Ewart Smith has pointed out that the rate of investment of capital in the United States from 1900 to 1950 was double ours; the lead in productivity possessed by that country is not simply a matter of building more power stations and mining more coal, but involves building more plants to use that energy. Experience since nationalisation has shown that the nationalised fuel industries are prepared to increase their capacity as fast as plant can be made available, provided that the Government will permit the expenditure. The State controls all capital expenditure with the object of ensuring that developments keep in step—another example of advanced collectivism. It is disturbing to observe, however, that, in practice, so large a proportion of the national income is being spent by all British Governments alike on luxury services of a collectivist character that there seems to be insufficient to provide the plant on which our livelihood depends.

The advances in social services, conditions of work and life are not only admirable but necessary. They have had, however, most unfortunate economic consequences which politicians do not yet appear to appreciate. I am constrained to ask whether political theory has yet adjusted itself to the conditions of the industrial age which started 150 years ago. There must be found some way of providing decent conditions of life for everyone without crippling industry and stifling enterprise by crushing taxation.

Capital expenditure on fuel production and utilisation may be regarded as coming under two heads. Under the first are large-scale projects, only possible to the State or organisations on a national scale, such as hydro-electricity, or the electrification of the railways. Under the second head are projects undertaken by individual firms within their own organisation. In both cases, planning should be bold and reasonably long-term.

The Institute regards education of professional fuel technologists as one of its main functions. This is an age when scientific knowledge is advancing rapidly and when techniques are changing. It is easy to fall behind and to become an intellectually "displaced person." To disseminate through our

* Entitled "Fuel and Society," delivered at a general meeting of the Institute of Fuel, held in London, Wednesday, April 22, 1953. Abridged.

*Journal* knowledge of advances in our special field must be a most important part of our work. Those who manage industry must have some special aptitude for the task, and it is here submitted that a knowledge of the rudiments of fuel technology should be a pre-requisite of many managerial appointments.

It is a common jibe among the ignorant that there are in industry, and particularly in the nationalised fuel industries, too many black-coated staff who appear to toil not nor to spin. In fact, under the conditions of a technological society, the opposite is the truth. Productivity teams returned from America comment on the much higher proportion of staff to manual employees in that country and on the greater degree of control of technological processes exercised by skilled technical staff. Sir Ewart Smith has shown that for a given level of fundamental scientific knowledge, a major influence on the long-term trend of productivity is the rate at which applied scientists are trained and used in industry. British industry needs many more technologists, and in particular those having specialised knowledge of fuel technology. To provide these men and to encourage their general employment in industry and the State must be a primary part of the work of our Institute.

It is comforting to reflect that the volume of research on fuel in this country is probably greater than that in any other subject of purely material import. Research is conducted on a large scale by the nationalised fuel industries into methods of production and utilisation; in solid fuel the British Coal Utilisation Research Association and the British Coke Research Association are at work; the Electrical Research Association deals with electricity; the Fuel Research Station embraces all forms of fuel; the oil industry maintains many large private research stations and, over the past 20 years, has had the highest rate of change of any fuel industry. In addition, there is a large volume of research conducted by contractors in order to maintain their competitive position. Looking farther ahead, should we not class the vast and expensive establishments devoted to atomic physics as fuel research? When civilised man wishes to destroy his enemies he uses energy to do it. That energy may one day replace the energy of coal for peaceful purposes.

Let me emphasise once more that although the temper of the age may be collectivist, the national rate of change still depends on the gifted individual. Mass production is only a matter of organisation. It must always be preceded by the creative thought of the genius.

Much educational work is needed to convince those to whom the fuel they use or incorporate in their designs seems to be a minor part of their profession, that adequate attention should be paid to it. To achieve that education should be a primary aim of any fuel-economy movement and it is a just criticism of recent proposals that such education has been neglected in their recommendations. This Institute, in recognition of this important principle, admits to corporate membership fully qualified members of allied professions, who have in addition adequate knowledge of fuel technology; and members of many professions that touch upon fuel technology are welcomed as non-corporate members (Associates) in order that they may have the opportunity of joining in the work of the Institute.

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WELDING DESIGN.—The Quasi-Arc Co., Ltd., Bilston, Staffs., has published two more design brochures. *Welded Plate Girders* deals with the design of girder components, their fabrication and other practical features; *Portal Frame Formulæ* gives formulæ for bending moments, etc., due to various loading systems on single-bay, single-storey frames.

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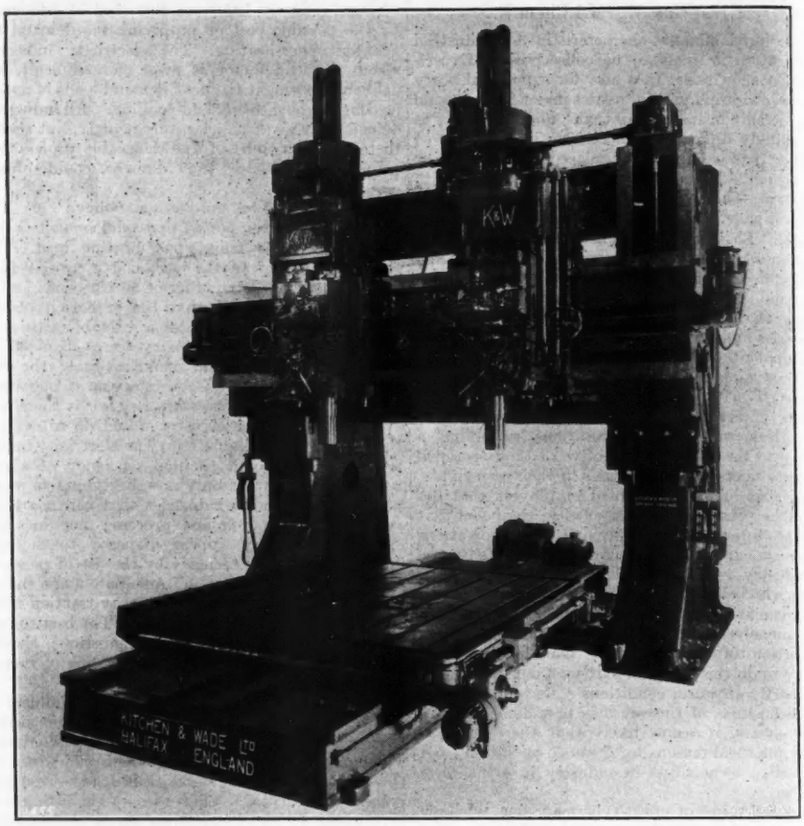
NEW ELECTRICAL FACTORY IN NORTHERN IRELAND.—The British Thomson-Houston Co. Ltd. have decided to establish a branch factory at Larne, Northern Ireland, and hope to start production in a pilot-plant in existing premises in about six months. When completed, the new factory will provide employment for from 200 to 300 workers of whom a high proportion will be men, but this may be increased to 1,000 within the next few years.

# DUPLEX BORING MACHINE.

KITCHEN AND WADE, LTD., HALIFAX.




## DUPLEX BORING MACHINE.

THE large duplex drilling, boring and screwing machine shown in the accompanying illustration has recently been made by Kitchen and Wade, Limited, Halifax. It has been designed for work on turbine-body steel castings. The two drilling heads are entirely independent of each other, and are made right and left hand. They have a minimum centre distance of 2 ft. 10 in. and their maximum centre distance is 10 ft. Each head is powered by a 15-h.p. motor and the drive is transmitted through an 18-speed gearbox to the spindle to give a range of speeds from 10 r.p.m. to 300 r.p.m. The spindle has a minimum diameter of 5½ in., and the nose is bored No. 7 Morse taper. A feature claimed for this machine is the range of screwing feeds, from 4 to 12 threads per inch, that are provided in addition to the 20 drilling feeds, with a range varying from 13½ to 120 cuts per inch; this enables holes from 2½ in. to 8 in. diameter to be screwed by a single-point tool, and such a tool has been specially designed by the makers for use with this machine. Forward and reverse friction clutches control the spindle rotation, and an automatic trip is fitted to the spindle feed to control the drilling depth. The length of the spindle feed is 27 in. and quick adjustment is provided by the four-lever control on the front of the head; a slight forward movement of any one of these levers engages the power feed. The fine feed is controlled by a hand wheel located on the lower part of the head.

The sideways movement of the drilling heads is obtained by either a hand operated or a power operated traverse. The cross-rail has a 4-ft. vertical adjustment provided by power-operated elevating screws equipped with safety nuts. The table is 10 ft. square and it has a 10-ft. power traverse; a high-speed drive on the table enables the operator to move work rapidly toward the spindles and then by pressing a button a slow feed of 3 in. per minute can be brought into operation to assist in obtaining the precise alignment required. A lock which is operated by a push-button is also coupled to the table traverse. The machine is claimed to be light in operation and is controlled by push-buttons which are of the duplex pendant type. It is provided with mechanical and electrical interlocks to ensure efficient and safe working. These prevent any movement of the traverse gear when the spindle motors are energised by making all traverse motions inoperative, and safety trips are fitted at the extreme positions on all the traverses. Automatic lubrication is provided for the gears, bearings, and slideways. The overall height of the machine is 23 ft. and the net weight is 68 tons.

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## TRADE PUBLICATIONS.

*Thermal Storage Systems.*—G.W.B. Electric Furnaces, Ltd., Dibdale Works, Dudley, Worcestershire, have sent us a copy of a catalogue dealing with their "Autolec" thermal storage systems.

*Films in Industry.*—An illustrated eight-page leaflet has been sent to us by British Optical and Precision Engineers, Ltd., 37-41, Mortimer-street, London, W.1, showing how films may be used in industry for recruitment and staff training, sales promotion, work study and design, as well as public relations.

*Waveform Analyser.*—Muirhead & Co., Ltd., Beckenham, Kent, have issued a leaflet giving details of the Muirhead-Pametrada wave analyser. An accompanying illustrated booklet shows the diverse applications for which this instrument has already been used in aeronautical, automobile, shipping and structural engineering.

*Gas Turbines.*—Particulars of the Turbomeca range of gas turbines manufactured under licence in the United Kingdom are given in an illustrated leaflet issued by the licensees, Blackburn and General Aircraft Ltd., 43, Berkeley-square, London, W.1. The range includes three air compressors with capacities ranging from 82 lb. to 167 lb. per minute of free air at pressures ranging from 41·2 lb. per square inch to 31·6 lb. per square inch; four shaft turbines, developing 158 h.p. to 394 h.p.; three jet engines, developing 220 lb., 350 lb. and 883 lb. static thrust, respectively; and a 795-lb. thrust ducted fan.

## MOBILE ENGINEERING LABORATORY.

FIG. 1. MOBILE LABORATORY IN MODIFIED FORM.

**Fig. 2.** *LAYOUT OF MOBILE LABORATORY.*

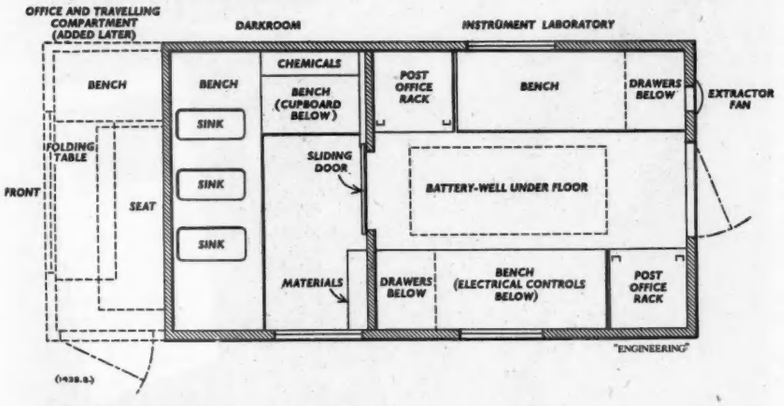
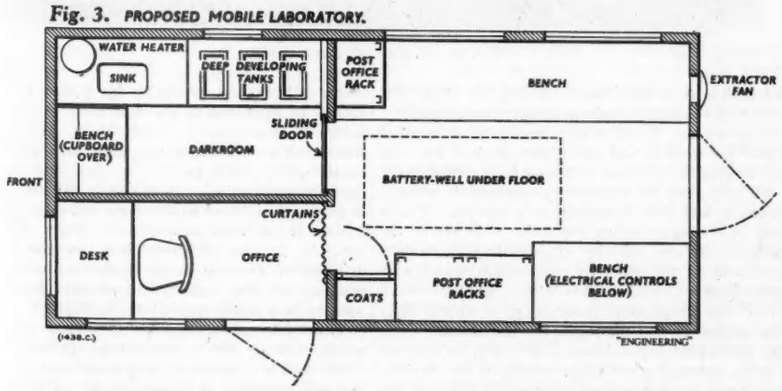



**Fig. 3.** *PROPOSED MOBILE LABORATORY.*




*Direct-Wire Alarm Systems.*—Full details of the direct-wire alarm system designed by them for use in generating stations and on distribution networks are given in a pamphlet received from Standard Telephones and Cables, Ltd., Aldwych, London, W.C.2.

*Control Desks for Telecontrol Systems.*—Control desks for telecontrol systems are the subject of a publication issued by Standard Telephones and Cables, Ltd., Aldwych, London, W.C.2.

*Crawler Tractor with Angledozer.*—A specification leaflet on the Challenger I crawler-type tractor, equipped with a "Bray" hydraulic angledozer-bulldozer having a 10 in. digging depth, has been published by John Fowler & Co. (Leeds), Ltd., Leeds, 10.

*Industrial-Type Contactor Starters.*—Four leaflets received from the Belmos Co., Ltd., Bellshill, Lanarkshire, deal with the various types of contactor starters which they manufacture.

*BK-90 Scraper.*—We have received from Blaw Knox, Ltd., 94, Brompton-road, London, S.W.3, their leaflet BK-172/1, superseding leaflet BK-172 and illustrating the latest BK-90 scraper for operation with 76-100 drawbar horse-power tractors of class II, group 2.

*Anti-Vibration Mountings.*—A leaflet dealing with the anti-vibration mountings they manufacture for carrying scientific instruments and light machines has been received from Howard Clayton-Wright, Ltd., Wellesbourne, Warwickshire.

## A MOBILE ENGINEERING LABORATORY.

By C. W. NEWBERRY, B.Sc.(Eng.), A.M.I.Mech.E., and R. S. JERRETT, B.Sc.

IN common with a great many research and experimental establishments, the Building Research Station, Garston, Watford, Herts, of the Department of Scientific and Industrial Research, is called on to undertake a considerable amount of practical work at a distance from the main laboratories, and measuring apparatus has to be carried to and fro in the course of the work. In the field of both physical and engineering measurements, the trend during recent years has been for the techniques to rely more and more on electrical devices of increasing complexity. Inevitably, then, a demand has arisen, first, for transport for the equipment, and then for an adequate mobile laboratory to provide a semi-permanent housing for the apparatus and suitable working conditions for the operators. The outcome of this demand was a mobile laboratory designed to meet the basic needs of investigators in the field of engineering research. The vehicle designed and used by the Building Research Station has proved to be adaptable and sufficient for a wide range of engineering test work, including electrical and photographic recording in situations remote from any main services, and a description of its principal features may therefore be of value to others faced with the problem of making engineering measurements in the field.

The mobile engineering laboratory was designed to provide a field base for engineering measurements, and, in particular, facilities for the transport and operation of cathode-ray oscillographs recording several channels, and for the processing of photographic records. Space was required for the accommodation of standard rack-mounted electrical units and for the various bench instruments that would be needed from time to time; also for work such as the preparation and adjustment of gauges, and minor repairs. The laboratory was to be self-sufficient at sites remote from all main services.

### GENERAL DESCRIPTION OF LABORATORY.

The mobile laboratory was originally designed in 1945 and was put into service early in 1946. The restricted supply of vehicles at that time limited the choice of a chassis, the only one available for the mobile laboratory being a Bedford OY 5-tonner, and this governed the size of the body. The internal dimensions were originally 13 ft. 1 in. long by 7 ft. 3 in. wide, with a ceiling height of 6 ft. 6 in. The body was of steel-frame construction with an external skin of steel sheeting and an internal lining of Masonite sheet, the cavity being filled with Isoflex to provide thermal insulation. The space available was planned as shown in Fig. 2, herewith, provision being made for an instrument laboratory 7 ft. 10 in. long and a darkroom 5 ft. 1 in. long, the width corresponding to the width of the body.

Although changes have been made from time to time in the services and equipment, the basic fitting of the laboratory has been found satisfactory and has been virtually unchanged since it was first installed. It was, however, soon found that the weight of the laboratory was putting an excessive load on the rear axle. The chassis was therefore changed when the opportunity arose and the mobile laboratory is now carried on an E.R.F. Diesel 8-tonner, which is better able to deal with the load. When the change was made, advantage was taken of the greater chassis length of the E.R.F. to add a small compartment to the forward end of the body to serve as a staff travelling compartment and as an office for use when the mobile laboratory is on a testing site. A general view of the laboratory, as now constituted, is shown in Fig. 1, herewith. The office compartment has proved to be a very valuable feature and would be incorporated if possible in any future general-purpose mobile laboratory designed at the Station. The present arrangements are shown in Fig. 2, but these would be modified in a future design to obviate the disadvantage of the office having no interior connection with the remainder of the vehicle. An improved layout, such as might be adopted for a future laboratory, is shown in Fig. 3.

# MOBILE ENGINEERING LABORATORY.

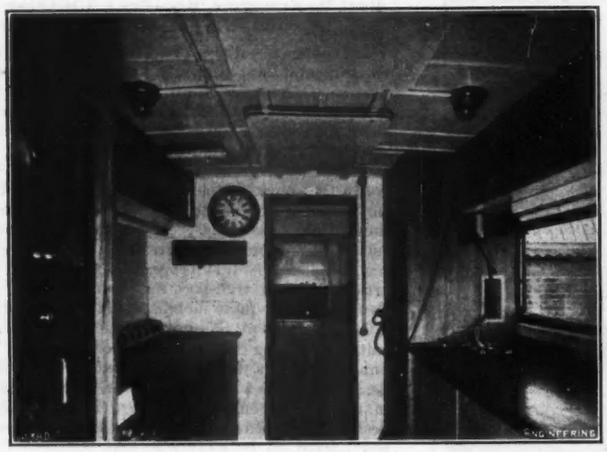


FIG. 4. INTERIOR FITTINGS.

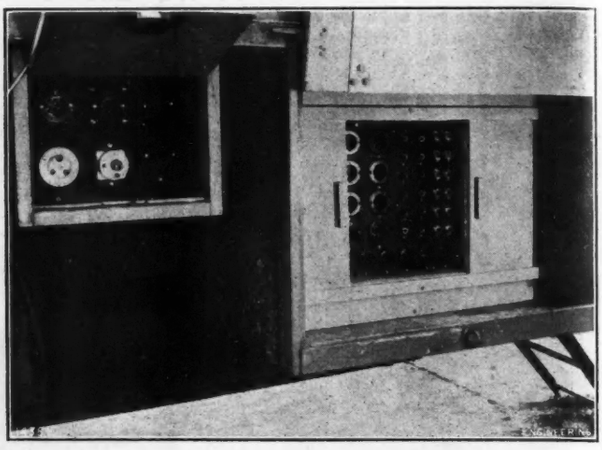


FIG. 5. INPUT PANEL AND DISTRIBUTION BOARD.

The external appearance of the mobile laboratory on its E.R.F. chassis is shown in Fig. 1 and in Fig. 6, on this page. The door in the near-side of the body gives access to the office compartment, which provides comfortable travelling accommodation for three persons. For office use, the folding table provides a desk space 4 ft. 0 in. by 1 ft. 6 in., and, at the far side, a fixed bench gives shelf space and carries a metal frame in which can be fitted instrument panels and communication equipment which may be needed to control a test. There are large front and side windows and artificial lighting is provided by a fluorescent tube over the window, fed by emergency 12-volt lighting run from batteries.

Entrance to the laboratory space is by the rear door of the vehicle. Detachable folding steps—the bottom step is designed to act as a boot scraper—are carried in a rack under the chassis, just above the spare wheel. The first impression of the interior, shown in Fig. 4, above, is of smartness and order, a condition which is deliberately fostered and maintained as being essential to efficient working in a confined space. This is helped by the internal finish of the laboratory, which is white enamelled on the walls and ceiling, and linoleum covered on the floor. All the woodwork is polished to facilitate cleaning. On either side of the instrument laboratory is a hardwood bench and a roll-front cupboard fitted with a standard Post Office rack in which are mounted amplifiers, control panels and such other electrical equipment as can be rack-mounted. The benches are fitted with flush metal inserts having tapped holes which serve as anchorages for bench apparatus when travelling. The space below the benches is used for drawers and storage cupboards, which are fitted for hand tools and equipment, and for control gear for the electrical services, a description of which follows later.

A feature which experience has shown to be very desirable, is the intake arrangement for the various leads and cables from the gauges and pick-ups on the test structure outside. It is generally unsatisfactory to have to run cables into the laboratory through the door or windows, particularly in bad weather. Two alternatives are possible: (1) to provide a suitable duct through which the cables can be pulled into the laboratory, or (2) to provide on the outside of the vehicle body an input panel to which the cables can be plugged, this panel being linked to a corresponding interior panel conveniently placed for feeding the instrument racks and bench apparatus. Both arrangements have been tried in this vehicle, and, while the former has the advantage of reducing the number of cable joints, the latter is preferred for ease and speed of working as well as for general convenience, and has proved quite satisfactory in performance. A panel is fitted to each side of the vehicle and housed within a protective box behind the rear wheel; some of the available contacts are shown in Fig. 5, herewith. The smaller panel on the left of this photograph is a distribution board for supplying power to tools and apparatus outside the laboratory.

FIG. 6. EQUIPMENT ON ROOF.

Windows are fitted above bench level in each side of the vehicle and the upper part of the rear door is glazed. All the windows have blinds and, in addition, can be completely screened to darken the laboratory for photographic purposes. Use is made of the space along each side wall above the windows, on one side by cupboards with sliding doors, and on the other by communications equipment which will be described later. At the forward end of the instrument laboratory, a sliding door gives access to the photographic darkroom. This room has a lead-covered bench, 2 ft. 3 in. from front to back, extending across the width of the vehicle. Three long, narrow porcelain sinks are fitted in the bench. Experience has shown that there is an advantage in arranging the long axis of the sinks along the length of the vehicle, for this minimises slopping if the vehicle has to be moved while solutions are in the sinks. Water is drawn from an overhead tank having a capacity of 38 gallons. Baffles in the tank prevent excessive surging of the water and no difficulty has been experienced with this quantity of water carried high in the vehicle. The tank may be filled in three ways: (1) by connecting a hose from a main water supply to a union under the body of the vehicle; (2) by running a hose from a union under the vehicle to a static water supply and pumping by means of a semi-rotary pump fitted in the darkroom (a filter being fitted in this circuit); and (3) by filling from a water-can directly into the tank through an inlet in the roof. This method is slow and would be used only if the other methods could not be used. A gauge glass fitted to the tank indicates the water level. It is very desirable to have hot water available in the darkroom and, for this purpose, a 1½-gallon electric water heater is installed over one end of the bench. An electric hot-plate is used to heat small quantities of solutions.

The darkroom is well fitted for storage of essential commodities. Above bench level against the right-hand wall is a roll-front cupboard sub-divided for the safe carriage of bottles of dry chemicals. At the other side is a small cupboard for sensitised photographic materials. The space under the benches and cupboards is specially fitted for carrying glassware and large bottles of solutions; it includes containers for chemicals needed in bulk, and a lead-lined waste box. Provision is made for passing spools of film between the instrument laboratory and the darkroom without admitting light to the latter. One flap of the hatch can be seen just above the bench on the left of the doorway shown in Fig. 4, and this hatch gives entry to a box sufficiently large to take a spool of film, the box being closed on the other side by a similar flap. The

two flaps are interlocked mechanically so that only one can be open at a time.

A permanent steel ladder gives access to the roof, which is fitted with lengths of duck-boarding to serve as a working platform when a high vantage point is desirable. Rails along each side of the roof are often useful as an anchorage for cables, particularly when it is necessary to support them clear of the ground, and brackets are fitted to carry an extending ladder on the roof of the vehicle. The exterior finish is important, for the vehicle may have to stand in exposed places for lengthy periods, yet it must afford protection for apparatus that is often expensive and which is generally susceptible to the effects of dirt and damp.

### Amenity Services.

*Lighting.*—The whole of the mobile laboratory is wired with two independent lighting circuits, so that advantage may be taken of a 230-volt supply when this is available, but a 12-volt battery system is available for lighting at other times. The 230-volt lighting was originally by filament lamps in bulkhead fittings but these have now been changed for fluorescent tubes which, in the confined space of a small laboratory, give a more uniform lighting with less trouble from shadows. Although rather close to eye level, they are well liked, causing neither glare nor eye strain.

*Heating.*—Some form of heating is regarded as essential in a laboratory of this type. It promotes the comfort and efficiency of the operators and assists in maintaining the equipment in good condition. In this laboratory the heating units were added after the laboratory had been built, and low-temperature electric heating panels (150 watts each) were fastened to the walls behind the instrument racks and to the ceiling of the laboratory, as shown in Fig. 4. The latter panels, totalling 1,000 watts, are backed by asbestos boards and spacing strips to prevent damage to the roof. Floor heating, where it can be fitted, and as used in the B.R.S. Mobile Acoustics Laboratory,* is to be recommended in place of the ceiling heaters. The darkroom is heated by a 250-watt panel mounted under the water tank, and the office by similar panels under the seat and mounted on the wall below the window. The total installed heating capacity is thus about 2 kW. Each of the compartments is fitted with a controlling thermostat.

*Ventilation.*—Ventilation is provided by an electric extractor fan fitted in the rear end of the vehicle. This draws air through both the darkroom and the instrument laboratory, a light-proof louvre being fitted in the partition between the two rooms and light-proof ventilators in the roof of each. The arrangement is not entirely satisfactory and a separate fan in each compartment is recommended.

### Electric-Power Services.

It will be apparent from the preceding description of the laboratory that considerable electric power is required for its full operation, particularly in cold weather. The potential demand is made up as follows: electronic equipment, 600 watts; power tools, soldering irons and electrical apparatus (including lighting) 2 kW; space and water heating, 2½ kW. The maximum demand is thus about 5 kW, though the laboratory can work on less by staggering the demand for services.

Power is normally fed to the vehicle through a weatherproof plug located under the rearside of the body, the supply being taken from mains, if available, or from a petrol-driven generator, trailer-mounted and towed by the mobile laboratory. The generator has a capacity considerably in excess of the power required by the laboratory, in order that changes of load shall have a negligible effect on output voltage and frequency. From the input plug, the cable passes through main fuses and a kilowatt-hour meter, necessary when payment has to be made for main supplies. The supply is then fed to three channels: (1) the raw main supply, which feeds panel heaters, water heater, battery charger, and output sockets on the benches and behind the racks; (2) a stabilised supply, obtained from a constant-voltage transformer, and available at bench and rack sockets (this supply is limited to 1·2 kVA and is normally reserved for electronic equipment); and (3) a voltage-adjusted supply, obtained from a Variac transformer, and fed to the fluorescent lighting circuit and to bench and rack sockets. The transformer enables the various supply voltages to be matched to the operating voltage of the equipment without alteration of the voltage tappings.

Emergency power supplies are provided by five 12-volt 100-ampere-hour accumulators carried in a well under the floor. These are quite distinct from the vehicle battery, which should be confined to its own normal function. Current at 12 volts is tapped for emergency lighting and is also available at plugs on the bench, the other 48 volts being fed to two rotary converters giving a 50-cycle output of 300 watts each at 230 volts, available at bench and rack sockets. The batteries are readily charged from either the mains or the generator, switching and controls being provided on the panel seen below bench level on the left of Fig. 4.

### Auxiliary Services.

The most important of the auxiliary services is the communications system, which often has to be provided between the site of the test instruments and the interior of the mobile laboratory, and possibly between various points in the case of an extensive test site. If the distances are short, an inter-communication telephone meets the case. The addition of a loud-hailer mounted on the roof of the mobile laboratory is recommended for use on open sites where it is necessary to give instructions to personnel moving about the site. In addition to this equipment, V.H.F. radio is installed in the vehicle for communication between various parts of the site when it is more extensive than can be conveniently covered by field telephone and when connection is required between mobile units. A link with the base laboratory, when within range, is also a convenience. For this purpose, sufficient low-powered sets are carried to cover the number of stations required. The system has proved itself invaluable and has greatly expedited the work of field testing. Also under the heading of communications, reference should be made to the need for a small run-about vehicle if testing is likely to take place on sites that are not reasonably served by public transport.

A further item of auxiliary equipment is a shelter of some kind for those members of the field team whose duties are primarily outside the mobile laboratory. The shelter may be a lean-to tent secured against the side of the vehicle, or it may be independent, but something of the kind is essential in a field test, particularly in bad weather, if the interior of the laboratory is to be kept free for working and not encumbered by the outside staff who will naturally seek shelter during those periods when they are not actively employed.

The mobile laboratory with its full equipment as described weighs between 8½ and 9 tons. It has seen considerable service, as a result of which its good points and deficiencies are fairly well known. It accommodates comfortably a staff of four or five persons and so can cope with test programmes of considerable magnitude and diversity. There are, in fact, few deficiencies, but three features might be improved. As mentioned earlier, it would be helpful to have internal communication between the office compartment and the laboratory. The existing floor level, 4 ft. 3 in. above the ground, involves considerable climbing during a day, often with traffic congestion on the steps; lowering the floor level would seem to be helpful if it could be achieved, though the vehicle must retain ground clearance for cross-country travel. Wider steps would be an added advantage. The use of deep developing tanks in the darkroom, instead of the sinks at present installed, would lead to some economy of space. With the arrangements suggested in Fig. 3, it would be possible to fit the equipment into a somewhat shorter vehicle if necessary. A mobile laboratory can only have the testing facilities that can be accommodated within a limited space, but the vehicle has proved itself adequate to the engineering work of the Building Research Station.

* P. H. Parkin, "The Design of Mobile Electronic Laboratories," *Journal Scientific Instruments*, vol. 29 page 8, (1952).

## AUTOMATIC SWITCHING FOR TAPE-RECORDING MACHINE.

An electronic recording and switching apparatus, evolved in the first place as a means for describing and controlling animated displays and exhibits, has been developed by Edgley Studios, Limited, Lansdown Place-lane, Cheltenham. Known as the Sonomatic electronic control unit, it also has application as an automatic telephone operator, announcer, or exhibition "conductor," and it can be used as a multiple-point sequence switch, with a repeatable predetermined time base up to 30 minutes, for controlling processes, etc.

The Sonomatic control comprises two units, one of which consists of a high-fidelity audio amplifier, a specially designed tape-recording deck, monitor speaker and operating switchgear. The other comprises a proximity switch, delay unit and high-gain signal amplifier, with associated selector switchgear to control external apparatus. The speech, or sounds, are recorded on standard magnetic tape. The proximity switch, when actuated by the presence of an audience or a body within the field of its probe, starts the tape-deck motor, and the recording is reproduced simultaneously with synchronised signals which transmit pulses to control the movement of the process or operation being demonstrated or performed.

The amplifier and tape-deck unit is fitted with two replay heads to transmit speech and signal to audio and signal amplifiers, respectively. A variable speed gear permits operation at tape speeds of 3¾ in. or 7½ in. per second, a stroboscopic indicator being provided to ensure accurate signal timing. A loudspeaker is incorporated to facilitate initial adjustment, and to monitor recordings where remotely-installed speakers are used. Separate controls and power supplies are provided for independent operation of the unit when the switching unit is not required. A microphone input for use as a public address amplifier is provided. In the switching unit, a sensitive capacity bridge-triggering switch operated by proximity to an electrode at the end of a 6-ft. coaxial cable closes a system of relays and starts the tape-deck synchronous motor. At the end of one performance the switchgear is automatically reset. The triggering switch is controlled initially by a pre-set time-delay unit. The external switching sequences are operated by pulses from the magnetic-tape signal channel fed to the high-gain amplifier in the switching unit. This circuit is designed to prevent "out-of-step" operation and provides automatic "homing" of the external mechanism in the event of tape break down or power failure.

## TEMPERATURE CONTROL OF MOLTEN GLASS FEEDER.

For ensuring efficient and consistent production of glassware from automatic machines, a temperature control system has been developed by Messrs. George Kent, Limited, Luton, Bedfordshire, whereby a constant temperature is maintained at the feeder spout. This ensures that the viscosity of the glass at the scissor mechanism is constant; thus production is speeded up, the number of rejects is reduced, and a speedier return to stable production after a stoppage is made possible.

In the Kent system, a platinum/platinum-rhodium thermocouple, immersed in the molten glass in the feeder, is encased in a platinum sheath to resist erosion. The thermocouple is connected to a Multelec recording potentiometer. Fitted inside the potentiometer case is a controller which, by altering the position of a diaphragm-operated valve in the high-pressure air line, regulates the high-pressure air supply to the inspirator of the glass feeder burners, thus varying the heat input to the combustion chamber. The control temperature may be set at any desired value. A manual control panel is also provided, under the potentiometer, to enable the operators to control the plant by hand during repair or when shutting down the plant or starting a new feeder. Signal alarms warn the operators when the control valve is at the limit of its travel in either direction.

## NOTES ON NEW BOOKS.

*Elements of Food Engineering. Volume I.*

By PROFESSOR MILTON E. PARKER, with the collaboration of PROFESSOR ELLERY H. HARVEY and E. S. STATELER. Reinhold Publishing Corporation, 330, West 42nd-street, New York 36, U.S.A. [Price 8·75 dols.] Chapman and Hall, 37, Essex-street, London, W.C.2. [Price 70*s.* net.]

IT is stated in this book that there are 25 different food-processing industries in the United States, operated by more than 39,000 individual firms. The industry is on a considerably smaller scale in Great Britain, but food processing, in its various ramifications, is one of the major industries. Strictly speaking, food is not "manufactured"; it may be cleaned, disintegrated, dried, evaporated, mixed, cooked, or a number of other things. Many of the processes to which it is subjected depend on chemical or bacterial action, but all require machinery or plant of some kind. The design and operation of such plant is the province of the food engineer. This book makes a distinction between chemical engineering and food engineering, but the argument advanced is not very convincing. The point, however, is not of importance; if the works engineer producing various protein derivatives, such as gelatine, from food stuffs cares to call himself a food engineer, there is not likely to be any objection. Although an engineer concerned with, say, the extraction and treatment of vegetable oils is not likely also to be engaged in the production of fermented beverages, it will, none the less, be of value to him to have some acquaintance with the whole field of food engineering. This book will give him the necessary information, as well as providing a clear and detailed treatment of his particular field. It is necessary to point out, however, that this volume is not concerned with the design of food-treating machinery. That would seem to be the subject of Volumes II and III, which are to appear. The present volume describes, in detail and clearly, the methods used over the whole field of food processing.

## CONTRACTS.

THE NATIONAL GAS AND OIL ENGINE CO., LTD., Ashton-under-Lyne, have received an order for a F2APX8-type engine to drive a 300-kW alternator at 500 r.p.m., from the Clermont Electric Authority, Queensland. A second order is from George Waller and Son, Ltd., Stroud, Glos., and is for an R4A3-type three-cylinder Diesel engine developing 150 brake horse-power, at 600 r.p.m., to be used for driving a gas compressor for the North Eastern Gas Board. A third order, from Spencer (Melksham) Ltd., is for a Diesel-engine set for mounting on a floating pneumatic plant. The engine will develop 120 brake horse-power, at 1,100 r.p.m., and will be directly coupled to an 81-kW 115-kVA alternator supplied by the BRUSH ELECTRICAL ENGINEERING CO., LTD., Loughborough.

THE NORTH BRITISH LOCOMOTIVE CO., LTD., Glasgow, have obtained an order from the Railway Executive for three 200-h.p. Diesel-mechanical shunting locomotives for use in the North Eastern Region. The engines will be of the 0-4-0 type having a total weight of 32 tons and a length over the buffers of 22 ft. 11¼ in. They will incorporate the Voith-North British system of hydraulic transmission.

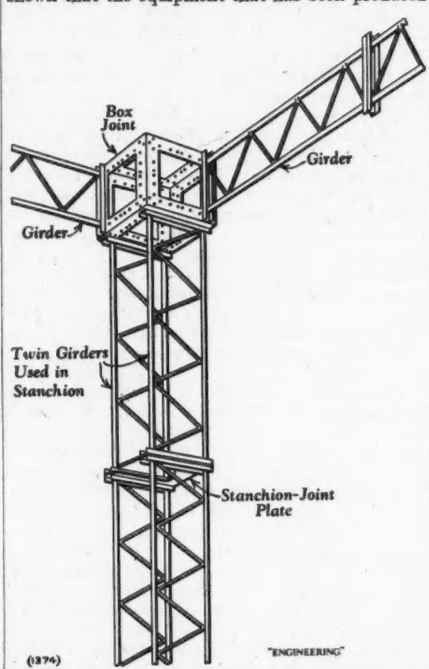
THE DREWRY CAR CO., LTD., City Wall House, Finsbury Pavement, London, E.C.2, are to supply and deliver two Diesel-mechanical shunting locomotives to Ipswich and Colchester, for the Eastern Region of British Railways.

VAUXHALL MOTORS LTD., Luton, Beds., have obtained a contract from the Belgian Government, valued at over 2½*l.* million, for the supply of motor vehicles for the Belgian Army. Most of the vehicles will be four-wheel drive models generally similar to the 3-ton load-carrying Bedfords supplied to the British Army and the Royal Air Force. The bodies will be furnished from Belgian sources.

SIMON-CARVES LTD., Cheadle Heath, Stockport, are to build a coke-oven plant at Margam for the Steel Company of Wales Ltd. The installation will comprise 90 compound regenerative ovens having a throughput of 1,650 tons of coal a day, associated coal and coke handling equipment, and a by-product recovery plant to produce crude tar, crude benzole and sulphate of ammonia. The clearing of the site has already begun.

## LIGHTWEIGHT STRUCTURAL FRAMING.

A SERIES of lightweight prefabricated structural elements that can be easily erected to fit a wide range of space requirements, and then be readily dismantled, has been produced by the Planning and Design Department of British Optical and Precision Engineers, Limited, Mortimer House, 37-41, Mortimer-street, London, W.1. The elements were originally designed to be used in the installation of temporary stage structures to carry curtains, scenery and lighting equipment. For this purpose the resulting structure had to be adaptable in size to suit the space that was available in a variety of buildings, it had to be easily erected and dismantled with safety by totally-unskilled labour, to be capable of being broken down into units for transport and, finally, it had to be of adequate strength to support intermittent and haphazard loading over considerable spans. Experience has shown that the equipment that has been produced




provides these features and it seems probable that it has applications in industry far wider than those for which it was originally designed; the equipment is, in fact, suitable for the erection of many forms of lightweight temporary frameworks.

The basic elements are few in number, the two most important being the girder section (which is of the basic element for both beams and stanchions), and a box joint. The girder, shown in the accompanying illustration embodied in a typical framework, is made in five lengths, in steps of 6 in. from 2 ft. 6 in. to 4 ft. 6 in., and is a Warren-girder type of lattice with top and bottom stringers of 1-in. diameter tube of 16 gauge mild steel, at 12 in. centres, cross-braced by ⅜-in. diameter rods that are welded to the stringers and with end posts cut from a small-section channel. These end posts are drilled at standard pitchings for ½-in. bolts, which are used for making all the connections; the same pitch of bolt holes is reproduced in all the other elements to give maximum adaptability in construction. The box joint, which is the prime element in the system and which is used for forming the connection between stanchions and beams, is built up from 16-gauge angle welded in the form of a hollow box; every flange of this box is drilled with a system of holes designed to marry up with those in the end posts of the girder sections. Other elements comprise the stanchion-joint plate and the floor plate, both cut from sheet steel and drilled to match the other elements, and a wall-fixing plate joggled to give easy erection on the wall with little cutting of the brickwork. For the easy attachment of cables, rails and equipment generally, the designers have provided a range of U-clips and other fixings. A typical assembly is shown in the illustration in which the beams are made from single girders (although these can be duplicated, if necessary, to give greater strength or to permit longer spans to be attained), and in which the stanchions have been built up with twin booms.

## BOOKS RECEIVED.

*Transactions of the Institution of Civil Engineers of Ireland.* Session 1950-51. Vol. 77. Falconer, 2, Crow-street, Dublin.

*Case Study Data on Productivity and Factory Performance. Street Lighting Luminaries.* Prepared for Mutual Security Agency, Productivity and Technical Assistance Division, by United States Bureau of Labor, British Institute of Management, Management House, 8, Hill-street, London, W.1. [Price 5*s.*]

*Generation, Transmission and Utilisation of Electrical Power.* By DR. A. T. STARR. Third edition. Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, Kingsway, London, W.C.2. [Price 20*s.* net.]

*Précis de Mécanique des Fluides à l'Usage des Ingénieurs.* By PROFESSOR M. SÉDILLE. Dunod, 92, Rue Bonaparte, Paris (6e). [Price 780 francs.]

*University of Illinois Engineering Experiment Station.* Reprint Series No. 50. *Electro-Organic Chemical Preparations:* Part IV. By SHERLOCK SWANN, JR. The Director, Engineering Experiment Station, University of Illinois, Urbana, Illinois. [Price 20 cents.]

*United States Bureau of Mines.* Report of Investigations No. 4938. *The Thermodynamics of Combustion Gases: Temperatures of Methane-Air and Propane-Air Flames at Atmospheric Pressure.* By R. W. SMITH, JR., H. E. EDWARDS, and STUART R. BRINKLEY, JR. The Secretary, Bureau of Mines, U.S. Department of the Interior, Pittsburgh, Pennsylvania.

*The Meigs Creek No. 9 Coal Bed in Ohio. Part I—Geology and Reserves.* By WILLIAM H. SMITH and others. *Part II—Washability Characteristics and other Properties.* By PROFESSOR PETER O. KRUMIN. Issued jointly as Report No. 17, Division of Geological Survey, Department of Natural Resources, State of Ohio, U.S.A., and Bulletin No. 151, Ohio State University Engineering Experiment Station, Columbus, Ohio, U.S.A.

*Notes et Formules de l'Ingénieur.* Edited by MAURICE DENIS PAPIN and JACQUES VALLOT. Vol. III. Automobiles, Aéronautique, Électrotechnique Générale. Editions Albin Michel, 22, Rue Huyghens, Paris. [Price 4,600 francs.]

*The College of Aeronautics, Cranfield.* Report No. 64. *Analysis of Two-Cell Swept Box with Ribs Parallel to the Line of Flight Under Loading by Constant Couples.* By D. HOWE. No. 68. *A Note on the Estimation of some Low-Speed Characteristics of Delta Wings.* By R. G. ROSE. The Librarian, College of Aeronautics, Cranfield, Bletchley, Buckinghamshire. [Price 5*s.* each.]

*United Nations. The European Steel Industry and the Wide-Strip Mill.* Prepared by Industry Division, Economic Commission for Europe, European Office of the United Nations, Palais des Nations, Geneva. [Price 7*s.* 6*d.*, or 4 Swiss francs.]

*The Nature of Creative Thinking.* A Monograph sponsored by Industrial Research Institute. Offices of the Institute, 60, East 42nd-street, New York 17, U.S.A. [Price 2 dols.]

*Wells and Boreholes for Water Supply, with Notes on Water Analysis and Purification.* By J. E. DUMBLETON. Second revised edition. The Technical Press Limited, Gloucester-road, Kingston Hill, Surrey. [Price 17*s.* 6*d.*]

*Transactions of the Institution of Naval Architects.* Edited by CAPTAIN (S) A. D. DUCKWORTH, R.N. (RET.). Vol. 94, 1952. Offices of the Institution, 10, Upper Belgrave-street, London, S.W.1; and Henry Sotheran Limited, 2, Sackville-street, London, W.1.

*Non-Ferrous Ore Dressing in the U.S.A.* Report of the Technical Assistance Mission No. 54. The Organisation for European Economic Co-Operation, 2, Rue André-Pascal, Paris (16).

*Mechanical Inspection.* By PROFESSOR W. H. ARMSTRONG. McGraw-Hill Book Company, Incorporated, 330, West 42nd-street, New York 36, U.S.A. [Price 5·50 dols.]; and McGraw-Hill Publishing Company, Limited, 95, Farringdon-street, London, E.C.4. [Price 47*s.*]

*United States Productivity Team Report. The British Electricity System.* British Productivity Council, 21, Tothill-street, London, S.W.1. [Price 3*s.*]

*The British Electrical and Allied Manufacturers' Association. Forty-Second Annual Report,* 1952-1953. Offices of the Association, 36 and 38, Kingsway, London, W.C.2.

*Welding Technology.* By F. KOENIGSBERGER. Cleaver-Hume Press, Limited, 42*a*, South Audley-street, London, W.1. [Price 25*s.* net.]